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# EMERGING CURRICULUM

A thesis submitted in fulfilment of  
the requirements for the degree of

Doctor of Philosophy

(Mathematics Education)

by

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## Abstract

In this autobiographical narrative study I consider how *curriculum*, in particular the mathematical curriculum, emerged for me throughout my life.

My aims with this study are:

- to show how my concept of curriculum has emerged and changed over time.
- to encourage others to envisage curriculum in a range of different, but complementary ways.

I started with a *naïve* view of curriculum—the *received* curriculum. While teaching this changed. I began to appreciate *levels* of curriculum (national, school and classroom), to realize that within the constraints of a *national* curriculum I had professional freedom and to understand how students *negotiate* curriculum. I also became aware of curriculum as a continually changing *process* rather than a *product*.

As an education officer in the curriculum development division, my views evolved further. I juggled with the conflict between *all planning for the classroom* and curriculum as government policy. My understanding grew about the *assessed* curriculum, the *global* curriculum, the development process (based on a *research-development-dissemination* model) and the notion that a curriculum should operationalize educational aims. I realized that contradictory perspectives on curriculum needed to co-exist.

In the last 15 years I worked in tertiary institutions. My scholarship focussed on curriculum-related matters. My view of curriculum became *multi-dimensional* and *complex*, with associated documents and development being inseparable from curriculum; and I formulated a model in which curriculum, development and other influencing activities are envisaged as a *complex living system*.

## Acknowledgements

The phrase *Laying down a path in walking* (Varela, Thompson & Rosch, 1991, p 237) describes what we do as we journey through life. I acknowledge the people who have laid down paths related to mine, some were shared, some parallel, some intersected only briefly; but each influenced me and enabled me to reconsider the direction of my path.

I have been fortunate to have walked with many people—family and friends, teachers and fellow students, teaching colleagues and students, co-authors, curriculum co-workers, university colleagues (academics, general staff, students and research supervisors) and conference, sabbatical, and international colleagues. Most of all at a more personal level, there are some very significant others who have been in my life—our hearts as well as our paths have been intertwined. There are too many to name, but I am sure they know who they are; and I hope they know in their hearts and their minds how much I acknowledge their contribution to my life, my work, and this study.

I have referred anonymously to many people in this study. They are not named for privacy reasons and because they may not agree with my interpretations of our interactions. Others have not been referred to specifically but are here in spirit. There are others with whom I have ‘travelled’ through their writing; some I have referred to in this work, a few I have met, but many have influenced me. I also acknowledge the institutions that have funded me and enabled my path to include many conferences and many countries.

I acknowledge that this study is autobiographical. It draws on previously published material which is referenced and chapters 4 to 8 in particular are a substantial development of an earlier paper (Begg 2000a).



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# **Introduction**

This study is about how curriculum has emerged for me, not about specific regional or national initiatives. It is autobiographical and covers 65 years of my life. I have worked in the field of mathematics education; my focus on curriculum reflects this, but the issues are of wider relevance. My aim is to stimulate debate on curriculum, not to provide answers, to suggest possibilities and to encourage others to envisage curriculum and the change process in multiple ways. The study has four parts.

*Part A, Setting the scene.* Chapter one provides an overview of the study, the second chapter summarises the main theoretical ideas that underpinned my thinking and the third looks at my approach to research in this study.

*Part B, Learning about curriculum.* In these four chapters I trace my involvement with curriculum as a young person, a teacher, an author and a curriculum developer.

*Part C, Reflecting on curriculum.* In these three chapters I reflect on curriculum from the perspectives of an academic, from my comparative curriculum studies and from semi-retirement.

*Part D, Summing up and looking forward.* In the final two chapters I draw together the strands of my thinking, weave in further ideas from the literature and offer future possibilities.





# **PART A   Setting the scene**

## **Chapter 1 Navigating a path**

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### **1.1   Introducing the study**

I have spent most of my life in New Zealand (NZ) and have enjoyed a broad range of educational experiences. When considering these experiences the unifying theme is what I regard as curriculum—though my ideas about curriculum have changed over the years. I use the word for *all planned activity for the classroom*.

My main purpose with this study is to share experiences and thoughts on curriculum in order to legitimate my view that there are many ways of envisaging curriculum and these change over time. My purpose is not to say what curriculum is, but rather, to stimulate debate on it, to encourage reflection on views held, to consider other possibilities and to appreciate the many ways in which curriculum can be conceptualised.

For me, looking backwards and looking forwards is a form of dialogic interplay. My past, present and future are not separate from each other. This fits with the notion of

building on one's prior experiences and with thinking of myself as a complex emerging living system. My past, the lessons learned (or mis-learned) and the opportunities taken or missed, have helped me become what I am now and from this has emerged the things that interest and concern me. Similarly, reconsidering future possibilities in my work causes me to continue to question my status quo. Thus, for the reader to make sense of my story I need to give some background.

In using the title *emerging curriculum* I am not referring to a particular round of curriculum development such as those currently underway in NZ and in other countries, but rather to what curriculum means and is coming to mean for me.

One purpose for this study was to get my work-to-date into perspective and review my direction. This fits with my belief, based on my experience, that the benefit of research is the growth of the researcher and the benefit of writing is in the writing process rather than in the presentation of the result. I made this project a doctoral study for a number of reasons: to discipline myself in terms of academic rigour, to benefit from the advice of colleagues as supervisors, to help establish autobiography as an approach to research within mathematics education and to demonstrate that a dissertation can also be a publishable book (rather than writing a book from the dissertation as is common in many English-speaking countries).

Throughout my involvement in education I have always been optimistic. I have seen initiatives come and go. Some took longer to be accepted than I would have hoped for, others lasted longer than I would have preferred, but generally they

have been part of long-term changing trends. These trends do not imply progress—I see evolution as meaning changing to fit the environment, so change can occur in any direction.

In considering my experiences and how curriculum is emerging for me, this study is a case study and as I am writing it, it is autobiographical. In it I consider various incidents from my life that seemed to have influenced my views of curriculum, or signified some shift in perspective for me. Motivating me to use this autobiographic approach was my success with a keynote address at an Australian conference (Begg 2000a); indeed some of the incidents in this study were first reported in that address.

While my career has been in mathematics education, other aspects of my life and education have influenced my views on curriculum. This study therefore moves beyond mathematics education to include consideration of ideas from other subjects that have influenced my thinking about mathematics education and aspects of education beyond subject knowledge to which all subjects contribute including the personal and social growth aims of education.

## **1.2 Changing times**

Since 1940 NZ society and education has changed considerably. Beeby (1986) discussed the educational changes in terms of what he calls the educational *myths* of the periods and notes that an educational myth *carries no hint of disparagement* and has *unattainable but approachable goals* (p xv). The myths can be thought of as:

Pre-1945	survival of the fittest
1950–1965	equality of opportunity
1965–1985	equality of outcomes

Beeby's myths fit with notions of schooling being for the sorting of individuals, education being an instrument of social policy, and the realization that education is not a neutral value-free activity (Renwick 1979). These myths reflect the changing aims of education in general and are likely to have influenced the aims of individual subjects. Since 1985 change has continued, for example the political rise of neo-liberalism with the associated growth of accountability and the increasing appreciation by educators of complexity. It seems that accountability is the dominant post-1985 myth, though I hope that complexity is in the ascendancy.

Since 1985 cohorts of students have changed. A typical student today brings very different experiences to school than one may have done twenty years ago. However, many structures have hardly changed within NZ's education system, for example, since the Thomas report (1943) on *the post-primary school curriculum* was implemented NZ has a centralized curriculum (or syllabi and examination prescriptions) and national assessment in years 11, 12 and 13 at high schools.

Within all school subjects change occurs partly because of new *myths* or *aims*, but also because of new developments within each subject. I have previously described the changes within school mathematics that I am aware of (Begg 1994a, pp. 3–5; 2000a, pp. 11–26) during my lifetime and these are summarized in table 1a.

Table 1a: *Changes in mathematics in NZ schools*

1940s	<ul style="list-style-type: none"> <li>- leaving age raised and some high school education becomes compulsory</li> <li>- mathematics becomes part of compulsory core in education</li> <li>- <i>core</i> mathematics introduced for non-academic students</li> </ul>
1950s	<ul style="list-style-type: none"> <li>- change from Euclidean to coordinate geometry in senior mathematics</li> <li>- calculus introduced into school mathematics</li> </ul>
1960s	<ul style="list-style-type: none"> <li>- growth of mathematical associations (and mathematics teacher journals)</li> <li>- <i>core</i> mathematics disappears; growing acceptance of <i>maths for all</i></li> <li>- introduction of <i>new maths</i> (emphasis on sets, logic and structure)</li> <li>- start of computer clubs in schools teaching simple programming</li> <li>- introduction of transformation and vector geometry</li> <li>- decimal currency introduced</li> <li>- applied mathematics (mechanics and statistics) replacing mechanics</li> <li>- experimental approach advocated for senior statistics</li> </ul>
1970s	<ul style="list-style-type: none"> <li>- metric system replaced imperial units</li> <li>- more emphasis on practical work at all levels</li> <li>- increasing emphasis on calculators and then on computers</li> <li>- statistics introduced into applied mathematics (years 12 and 13)</li> <li>- increasing acknowledgement of needs of less-able senior students</li> </ul>
1980s	<ul style="list-style-type: none"> <li>- computer studies replaces computing taught within mathematics</li> <li>- computers (numerical analysis) into applied (and pure) maths (yr 12 &amp; 13)</li> <li>- increasing emphasis on mathematics rather than arithmetic in years 7 &amp; 8</li> <li>- statistics emphasised in mainstream courses at high school (years 9–13)</li> <li>- mechanics dropped from mathematics (years 12 and 13)</li> <li>- swing back from the excesses of <i>new maths</i></li> <li>- project work emphasised (and used to supplement external assessment)</li> <li>- international trend (Cockcroft Report 1982; ICME Adelaide 1984)</li> <li>- calculator use becoming more widespread</li> <li>- problem solving emphasized</li> <li>- bilingual mathematics programmes starting to be developed</li> </ul>
1990s	<ul style="list-style-type: none"> <li>- more emphasis on needs of less academic students in years 12 and 13</li> <li>- further emphasis on technology</li> <li>- emphasis on processes (doing) rather than only on content (knowing)</li> <li>- mathematics and statistics replacing arithmetic at all levels from year 1</li> <li>- mathematics positioned within an overall curriculum framework</li> <li>- increasing consideration of ethnomathematics</li> <li>- development of Pangarau (mathematics curriculum in Maori for Maori)</li> </ul>
2000s	<ul style="list-style-type: none"> <li>- numeracy project emphasising number focus</li> </ul>

### 1.3 Separating phases

My involvement in many of the changes listed in table 1a justifies my claim of *a broad range of educational experiences*. This is further justified by my work experience that I have summarised in table 1b and is detailed and reflected upon in the later parts of this study.

Table 1b: *Time-line—seven phases or ages.*

1	1940 – 1945	Living as a young child at home
2	1945 – 1962	Learning in educational institutions and informally
3	1963 – 1983	Teaching high school mathematics and writing textbooks
4	1983 – 1989	Developing curriculum for the Department of Education
5	1989 – 2000	Teaching and researching at university
6	2000 – 2005	Working in semi-retirement
7	2006 – ??	Pondering the future

While most of my educational involvement was in institutions there were numerous informal occurrences that influenced my thinking and I have included these in the appropriate phases.

The first two phases, 1940 to 1962, are discussed in chapter 4. My time in teaching is the focus of chapter 5, while textbook writing that occurred during the same time period, is discussed in chapter 6. Phase four, working in the Curriculum Development Division (CDD) of the NZ Department of Education, is the subject matter in chapter 7. My ideas and experiences that emerged during my work in the graduate centre at university are discussed in chapters 8 and 9, and semi-retirement, my current phase, is the focus of chapter 10. The final two chapters synthesize my thinking by looking both backwards and forwards.

These seven phases might suggest the biblical life span of *threescore and ten* (Psalms 90, v 10) or as Shakespeare (1600, Act 2, Sc. 7, Lines 139–166) described the *seven ages of man*—infant, schoolboy, lover, soldier, justice, pantaloone and second childhood/oblivion; to date only some of these categories fit. I prefer a metaphor that links seasons and age bands—spring 0–20, summer 20–40, autumn 40–60 and winter 60 – 80. Spring represents my years before paid employment,

summer my years teaching in schools and writing textbooks, autumn my time as a curriculum officer and an academic and winter represents semi-retirement—time to reflect and to carry on with work at a rather less hectic pace.

My career in education can also be compared to a journey, ever upwards, with each phase working towards a plateau, a resting point, or a phase transition point before the next phase gets fully underway. Indeed, my career shifts were mainly undertaken when I felt a need to move on. Two of them were somewhat forced by work restructurings, though even then I had a sense of it being time for a change.

The notion of plateaux to describe the end point for each phase came when attending a conference with a student and hearing a paper (O’Riley 1998) that used the notion of plateaux that had been developed by Deleuze and Guattari (1988); the concept appealed. A plateau suggested a sense of achievement in one’s intended direction and a plateau in one’s work suggests a needed rest for consolidation and a gathering of strength for the next challenge. In many ways life seems like a series of plateaux, so the notion fits well with autobiography. My first major plateau was beginning a career in teaching, this was preceded by mini-plateaux, starting school, leaving home for boarding school, starting university and teachers college. This was followed by further mini-plateaux as I progressed through various positions in teaching. In parallel another series of mini-plateaux unfolded as my career was enriched through my work with textbooks. This pattern of major plateaux continued through later stages of my career culminating with *semi-retirement* though again that was merely the start of another series of mini-plateaux.

In presenting these phases in a linear or serial sense I misrepresent the development of my knowing. Much of it occurred in parallel rather than sequentially. There were movements back and forth, and numerous tentative stages. My ideas about mathematics, learning and curriculum started subconsciously at a young age and have not stopped changing. My thinking about complexity emerged slowly as simple answers based on *cause and effect* gradually seemed unsatisfactory and I began to appreciate the interrelationships between most aspects of our lives. Boundaries became increasingly fuzzy. For example, I became aware that what I might have thought of as professional development might also be adult learning and wondered whether that was different from other forms of learning and research. Finally, and due largely to Maturana and Varela (1987), I reached the stage where I saw little need to separate learning from living. In a similar way I had thought of development in four ways—related to the teacher, curriculum, resources and assessment; but now these merge for me.

Deleuze and Guattari (1988) also talk about *rhizomes* in their discussion of *plateaux*. Rhizomes are part of the underground and less visible networks that underpin the growth and development of some forms of plant life. However a *plateaux* structure is easier to structure than a rhizome one and these notions merge with ideas of complexity. In mentioning both *plateaux* and *rhizomes*, I am illustrating the constant *niggle* I feel to investigate different structures and metaphors for much of our work including notions of curriculum.



## 1.4 Describing curriculum

The traditional view of curriculum that some teachers have and many parents hold is *a list of topics* for a course of study. This is reinforced by the dictionary (Little, Fowler, Coulson, & Onions 1959) definition for curriculum (and for syllabus)—*a regular course of study*. The term *examination prescription* is also common in education and it refers to the list of topics to be taught that may be examined. While working in the curriculum development division colleagues used the definition for curriculum, *all planned activity for the classroom* (Shaw 1983). This broadened my thinking as it explicitly involved not only what is taught but also how it is taught.

During the 80s there was debate about international comparative studies (the Second and Third International Mathematics and Science Studies, SIMSS & TIMSS) which colleagues in the Department of Education were involved with. The notion of *levels of curriculum* was discussed and seemed logical. In 1994 I listed nine levels, see table 1c.

Table 1c: *Nine levels of curriculum*, (Begg 1994b).

1	National	From a central educational authority
2	Local or regional	From a local educational authority or from a cluster of schools
3	School	Usually a school scheme
4	Planned	Individual teacher's lesson plans
5	Taught	What is actually taught to the class
6	Learnt	What is actually learnt by individual students
7	Assessed	What is assessed or though likely to be assessed
8	Commercial	Textbook or resource authors' interpretation
9	Hidden	Unplanned learning activity

Other levels could be considered, for example: the global or international curriculum, the ideal curriculum and the remembered curriculum. The nine listed in the table together with these three show one way in which curriculum can be interpreted.

It is reasonable to wonder why my focus is curriculum. Education is concerned with the growth of learners and for me curriculum implies the active planning and facilitation of such growth. As such it reflects the intentions of the curriculum designer at regional or individual class level and brings together what is taught, how it is taught, how it might be learnt and how it will be assessed. This view fits with the notion that the curriculum is always pre-planned, but discerning both the planned and the taught suggests that teachers will make adjustments in response to the learners in their classes—that is, planning is ongoing.

Early childhood, primary, secondary and tertiary education are often separated but I see them as part of a continuum. I see mathematics not as a separate subject curriculum (though I did not always), but as part of a whole school curriculum. I see challenges that arise within one subject as often having parallels in other subject areas—thus, while my experience is mainly with school mathematics, I believe that aspects of this study will be useful beyond mathematics. I acknowledge that mathematics can benefit from developments in other subjects although I have seen little evidence of this in practice, particularly in post-primary education. Cross-fertilization between subjects makes sense as most teachers who teach mathematics work in primary school, for them mathematics is merely one learning area within the curriculum, they see a need for coherence between subjects and teaching approaches.

## **1.5 Researching professional development**

In the 1990s I completed a research project focussed on professional development (Begg 1994a) because I believed that a number of curriculum innovations were not being implemented as intended. I assumed that improving teacher development would help curriculum implementation and identified the desirability of empowerment, ownership and continuity as factors influencing professional development. Now I no longer see good professional development as the key element for successful curriculum implementation. There are many other factors and this study shows how I came to see a different and more complex model for educational development as better explaining what occurs in practice.

## **1.6 Focussing my research**

If I had been embarking on a study of mathematics curriculum in the 1960s or 1970s I would have used a quantitative approach to obtain a broad consensus view on:

- the nature of mathematics,
- reasons for teaching the subject,
- the meaning of curriculum, and
- how curriculum might best be developed.

At that time I believed that a statistical analysis would indicate a way forward. In the early 1990s I would have assumed that a qualitative study would be more appropriate as I could see a major difficulty with statistics—while statistics is intended to handle variation, it often hides it and diverse opinions often need to be celebrated. I would have assumed that one answer to a question is often inadequate because responses

are likely to come from respondents with different perspectives and an appropriate way to present a range of responses would be needed.

Now I see traditional quantitative and qualitative approaches as reflecting an analytic and mechanistic approach that no longer seems appropriate. In rejecting these I chose to use autobiography or narrative writing as I believe that this is a more appropriate approach considering my purposes in undertaking this study, although I acknowledge that autobiographical research is subjective and address this issue in chapter 3.

The focus however remains—I am concerned about:

- the nature of mathematics,
- why mathematics is taught,
- what curriculum means, and
- how curriculum develops.

However, I no longer see these questions as isolated from each other and other issues impinge on them, with my interpretation of curriculum, the four foci and the related issues come together for me with the question, *how has curriculum emerged for me?*

## **1.7 Recurring themes**

A number of themes related to curriculum have recurred in various guises at different times in my life and these will be signalled with appropriate sub-headings. The main ones, interpreted broadly, are:

mathematics [the nature of]

curriculum

learning and teaching [theory and practice, contexts]

motivation [intrinsic and extrinsic, expectations]

assessment

policy [educational aims]

other subjects

relating to others [personal and social development]

These themes form a sub-framework that structure my story in particular in my years in schools, that is in chapters 4 and 5.

## **1.8 Making assumptions**

As part of this overview I see a need to discuss assumptions that underpin my thinking. My fundamental assumption is that we make assumptions all the time. Some are made consciously, but many are made without our being aware of them. I see assumptions, values and attitudes as part of constructed knowledge. These constructs are often disconnected and sometimes contradictory yet form parts of who we are. It seems desirable to make relevant assumptions explicit in my research because they influenced my justifications and the rationale behind my opinions and will help readers know where I am coming from so that they might understand how I reached my conclusions. However, identifying assumptions is not easy as they change over time.



One assumption that has changed for me stands out, it is my acceptance of the dichotomies of self/non-self or self/world, which had led to subject/object, mind/body, and knower/known. These Cartesian dichotomies were the cornerstone of western philosophy but have become problematic. They come from the traditions of individualism in Aristotelian philosophy and from Judaic and Christian religions. Damasio (1994) refers to them as *Descartes' error*. For me these dichotomies extend into the separation of mathematics from other subjects, topics within mathematics, learning from teaching, schools from life, schooling from education, past from present, work from play and conscious from unconscious knowing. This dichotomous thinking contrasts with Eastern thinking in which contradictory elements are often juxtaposed and seen as complementary. In rejecting these dichotomies, I accept Davis's (1996) point that Descartes' ideas provided a new way of seeing the world, caused us to rely on reason rather than on our senses and led us to seek better representations of reality. However, they led us to an analytic rather than a synthetic way of thinking and a search for *cause and effect* reasoning even with complex situations.

I have already mentioned some assumptions that I have made. Three of these were to do with research, my assumption that all research is subjective; that research involving autobiography and hindsight is particularly subjective; and that the main benefits from researching are related to the growth of the researcher. With these assumptions of subjectivity together with my views about the personal construction and enactment of knowledge, it is sensible to use the *first person* to report this study. I have also stated my assumption regarding the desirability of debate,

experimentation and consideration of alternatives. This assumption developed very early in my life (see incident 4.9) and was reinforced by my interest in eastern philosophy that began at about age 15 and continues. Thus I do not see alternatives as this *or* that, but rather as this *and* that. This same assumption led me to see, in terms of the Cartesian dichotomies, value in studying different aspects of a topic, but also trying to look at the whole.

I assume that in my early years my actions were guided by naivety, a blissful ignorance of subtlety and a confidence based on a privileged upbringing and a lack of failure rather than on wisdom—one might say half ignorance, half arrogance. I am hopeful that there is some evidence of responsibility and a growing awareness of what I did/do not know in later phases of my life, though I acknowledge that any change that occurred was gradual.

Four other assumptions that have emerged and evolved are important because they underpin this work. The first is about learning, the second concerns the nature of knowledge in general and mathematics in particular, the third is to do with curriculum and change and the fourth relates to systems. As these four topics are central to my thesis, I will allow the changing assumptions to emerge throughout my story but as I write with hindsight it seems sensible to mention my current assumptions. My present view of learning is an enactivist one that elaborates on radical constructivism by assuming that all living is learning and that one cannot separate knowing from the knower. I see knowledge as being much more than rational knowledge, including as it does knowledge gained through all the senses,

intuitive knowledge and subconscious or bodily knowledge. Mathematics for me is not a series of facts and procedures to be known and understood, but rather, a way of thinking about one's world which complements the ways of thinking that one learns from other experiences and subjects. I see curriculum and the associated change process as being dynamic, continuous and existing and being able to be interpreted in many ways at many levels. Finally, systems, or systems thinking, is a holistic way of thinking about most aspects of life and work that complements the analytic approach which is often used when making sense of phenomena. These assumptions will be more fully explained in chapter two where I discuss some of the underpinnings of this study.



## **Chapter 2 Underpinning ideas**

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### **2.1 Organizing ideas**

Throughout the period reported in this study my ground shifted significantly. I learnt new things, I looked at things differently and my theoretical positioning altered.

These positions relate in particular to learning and teaching, knowing and knowledge, mathematics, complexity and systems, learning systems and curriculum, which link with the recurring themes from 1.7. This chapter briefly describes some of my changing understandings of these theoretical perspectives rather than the theoretical perspectives themselves so that in later chapters I can refer to my positions without having to explain them in detail.

### **2.2 Learning and teaching theories**

As head of the NZ Department of Education, Beeby, possibly the most influential educational administrator that NZ has known, wrote, (Beeby 1986, p. xix):

The list of names that came over New Zealand's educational horizon in the 1920s is still impressive: John Dewey, Freud, Jung, Cyril Burt, Charles Spearman, Susan Isaacs, Percy Nunn, J.J. Findlay, A. S. Neill, even the youthful Piaget. For teachers trained on the psychology of Herbart, Stanley Hall and William James, it was heady stuff ...

In my experience within mathematics education, some fifty years after Beeby, I see a different list of names, and theories more than names, as being influential. Dewey and Piaget have remained influential and A. S. Neill for me (because of my involvement in alternative education). The more important influences during this study focus around *direct instruction*, *associationism*, *behaviourism* and *constructivism* and I will discuss these first. Seven other influences on my thinking are enactivism, Dewey, gestalt education, Neill, Rogers, Krishnamurti (in particular his 1956 book) and learning by observing. Of these I will discuss enactivism as it explains my present position and make some general comments about the others.

Theory and practice are not separate for me—from an enactivist perspective actions constitute theory. A theory may influence behaviour, but is also a way of articulating and creating coherence of action, of making sense of actions. A theory is useful when it provides insights into practice and guidance for planning. Different learning theories provide different ways of making sense of learning, that is, they provide different insights. Teachers seem to base their practice on personal theories that are often unarticulated. Such theories emerge from research or reflection (conscious or subconscious) on practice and can be influenced by fragments of theories that they have heard about or have had imposed on them, for example by school philosophies or by assessment regimes. Personal theories are not always well understood and they change over time; this fits with the postmodernist idea that there is no meta-narrative, no grand theory, no absolute truth that explains things. I have regularly written about learning theories and much of the following are revised excerpts from one such paper (Begg 1999c).

### ***Direct instruction***

During my early schooling (until the late 1950s) I was not aware of the influence that theories about teaching or learning seemed to have on teachers. I assumed they knew what students should learn and their job was to *transmit* it. They seemed to think of themselves as teachers (or lecturers or professors), their job as teaching (or lecturing or professing) and to use what is often referred to as *direct instruction*. They told students what was to be known, told them to learn it and in mathematics provided practice examples. This was referred to as *drill and practice* (a notion strengthened with associationism), but their intention was probably drill for understanding, though not quite in the way that Marton & Booth (1997, p 44) describe it for Asian students. As a pupil I had initially accepted the teacher's authority and knowledge, but even at primary school I started to question it (see incidents 4.3 & 4.10).

### ***Associationism***

In 1922 a small book appeared, *The Psychology of Arithmetic* (Thorndike 1922), it outlined a theory called *associationism* that was an early form of behaviourism.

Thorndike argued that behaviour could be broken into two main components (stimulus and response). He described how bonds are made in learning situations, discussed what might be done to strengthen them and identified *drill and practice* as critical in this process. He sought a careful analysis of the subject so that an ordered list of necessary bonds was available and argued for meaningfulness and relevance.

His two main contributions were to ask for a careful analysis of the subject and to cause the implications of psychological theory to be considered with respect to instruction (Resnick & Ford 1981). While other psychologists argued for more

meaningful instruction, the notion of drill and practice was taken up by many mathematics teachers, during my lifetime and Thorndike's thinking appears to have contributed to the later acceptance of behaviourism.

### ***Behaviourism***

With behaviourism as with associationism, stimulus and response were emphasised. Behaviour was envisaged as the product of conditioning or reacting to stimulus. An important influence on educational thinking in NZ being the book by Skinner (1953), *Science and Human Behaviour*, and since the mid-1950s, in NZ as in many Anglo-American countries, the dominant theories in education have been behaviourist ones and in the current decade this theory still dominates some governments who push for outcomes-based learning. With behaviourism knowledge is broken into specific behavioural objectives, stimulus material is provided, rewards are used to reinforce correct responses and the focus is on measurable behaviours rather than learners' thinking. The emphasis on behavioural objectives was an explicit focus in the parts of my own teacher education that related to lesson planning and most teachers of my generation were conditioned and still think, at least to some extent, about lesson planning in this way. Some specific behavioural teaching approaches such as mastery learning flourished for a short time in NZ and I used individualised and group versions of such an approach (see 5.4 & 5.5).

With mathematical and other subject knowledge, the focus on behavioural objectives is apparent in curriculum documents where knowledge is broken into series of goals that are presented as small, specific and discrete. From a consideration of various

logical or psychological hierarchies these goals/objectives were ordered into sequences that people saw as natural progressions, each was taught as the teacher worked through the progression hoping that most students would master each objective. The result of such an analysis of knowledge into objectives and the organisation for learning might be represented by figure 2a with the content of each objective being represented by a circle and the arrows suggesting the progression.

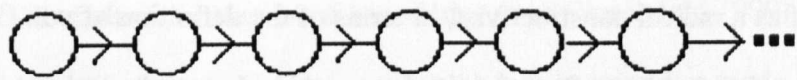


Figure 2a: A behavioural knowledge organizer

Such an organizer was apparent in NZ within mathematics curriculum documents (Department of Education 1985, 1987; Ministry of Education 1992, 1994) and with assessment where progression and levels of achievement reflect a sequencing of objectives. Stenhouse (1975) criticised such an analysis of subjects into objectives. He argued that it mistakes the nature of knowledge which is *primarily concerned with synthesis* and the *analytic approach implied in the objectives model readily trivializes it*. I see learning progressions as self-fulfilling prophecies. If one plans, teaches and assesses on the basis of progressions, then one interprets the results accordingly. However, teachers need teaching progressions—they may develop them themselves or use those from textbooks, teacher guides, or a curriculum. My hope is that such progressions include lessons that emphasize connections and synthesis.

While teaching I became dissatisfied with behaviourism as it did not seem to explain the complexity of teaching and learning, though with hindsight I recognise that there are elaborations of basic behaviourism that I had not considered.



## ***Constructivism***

Constructivism was hardly more than a word to me when I started working in the curriculum division in 1983 but I soon found out more about it. This theory seemed to explain much of what had occurred in my classrooms and the words *making sense* suggested teaching for understanding rather than behaviour modification. As I became more familiar with some of the variations of constructivism, I identified myself as a radical constructivist, in terms of the definition of von Glasersfeld (1990, 1995) and some time after my initial conversion I moved a little so that my radical perspective did not ignore the social, historical, cultural and language influences. For me radical constructivism (from von Glasersfeld 1990) implied that

- knowledge is not passively received through the senses or by communication, it is actively built up (constructed) by each knower/learner,
- knowing is an adaptive process with ideas evolving so that they fit with prior knowledge, and
- knowing is about making sense of and interpreting one's experiences, not about knowing any objective reality.

Other versions of constructivism emphasized social, historical, cultural and language influences. I assumed these were part of each person's experience and emphasized the uniqueness of each person's constructed knowledge schema—this emphasis at least being partly due to reflecting on my experiences with a twin brother, similar background and classroom experiences, but many different understandings.

Constructivist ideas date from at least Xenophanes, a 6th century B.C. sceptic, who said that if someone described exactly how the world really was, they would have no way of knowing that it was a true description (von Glasersfeld 1990). This major argument of the sceptics for the last 2500 years assumes that all ideas and knowledge gained is derived from our experiences—our senses, our acting and our thinking. These ideas were made explicit by Vico who lived from 1688 to 1744 and wrote a treatise in 1710 on the construction of knowledge (von Glasersfeld 1990) in which he said that *the human mind can only know what the human mind has made*. This statement differentiates between knowledge of the real world and knowledge of the world as a mental image that we create from our experiences.

Constructivism had come largely from the work of Piaget (1937) and Vygotsky (1962). Piaget's work was already influential within NZ, but mainly in terms of ages and stages of development. Initially the influence of constructivism was within science and mathematics education though it soon spread to other subjects. Piaget's version is sometimes called developmental constructivism, while the work of Vygotsky is termed social or socio-cultural constructivism. Vygotsky believed that one makes sense of the world in ways that are historically and culturally specific. His view of instruction was that interaction with adults or more advanced peers was necessary for development and that this required the active involvement of all participants. He assumed that instruction influenced development, that the teacher can intentionally nurture and teach children only in collaboration with them and that this process requires the teacher to operate within the learner's *zone of proximal development* (Howe 1996), that is, in Vygotsky's words (1978, p 86):

... the ZPD is the distance between the actual development level as determined by independent problem-solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers.

I see social and radical constructivism as complementary theories. Both assume knowledge is relative, radical constructivists need not deny the importance of social interactions nor that experiential worlds are historically and culturally specific and social constructivists may accept that negotiated understandings do not exclude the notion that different individuals may have different constructions. I see the two perspectives as ways of looking at knowledge construction, one reflecting Piaget's background as a biologist and emphasising the organising and adaptive individual, the other reflecting Vygotsky's background in a communist state where collective phenomena were emphasised.

For me the following *thought experiment* from Jaworski (1994) provides a way of thinking about constructivism.

Imagine arriving at a conference at an unfamiliar venue in an unfamiliar city. Think about how you develop a '*mental-map*' of the place from the moment you first arrive. Your 'map-making' might be aided by a plan of the venue, a map of the city, and by verbal instructions. You will build your knowledge up over time, partly shaped by your expectations, but largely as a result of your experiences, you will develop a 'map' of the venue and city that is adequate for your purposes even though it does not involve all the actual details.

This thought experiment emphasizes active experience during learning, active listening or map-reading, consideration of explanations and prior experiences which are all reconsidered and adapted to fit new experiences. Expectations are based on prior experiences in terms of what you expect in virtually all cities and what you assumed from other conference participation. Learning is the organisation of these experiences to make a coherent and viable picture of one's world. Of course



*meaning-making* is individualistic—different people's experiences in a city at a conference are different, so different mental maps are constructed but their commonalities mean that communication can be effective.

The idea of mapping meaning suggests a mental model, a concept map, a graph or network as a way of thinking about knowledge construction. In constructivism this is often called a knowledge schema. The facts, concepts, skills and procedures might be thought of as circles (see figure 2b) while the lines joining the circles in the figure represent the relationships between them. The relationships might be strong, weak, or tentative; they might be uni- or bi-directional; and some may not yet exist.

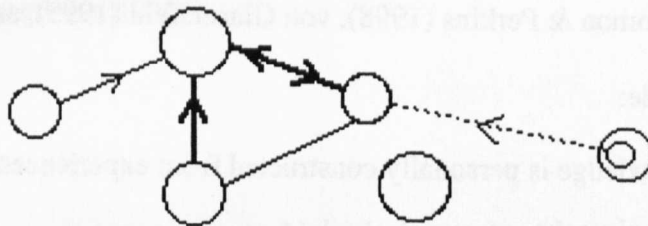


Figure 2b: *A constructivist knowledge schema*

Using this metaphor for knowledge one can think of learning as adding nodes to a particular schema, strengthening links between nodes and discarding incorrect ones, and making more links so that more ideas are connected. With this metaphor, mastery is not an adequate notion because an individual's networks will be unique to the individual (though it will include many commonalities or shared understandings) and because each network will be continuing to change as a result of a learner's experiences over time.

This schema differs from the behavioural one in a number of ways. Firstly, it moves the emphasis from *analysis* (of a subject into objectives) to a *synthesis* where subject knowledge is seen more holistically. Secondly, knowledge is thought of as a network of related ideas rather than a predictable linear sequence and this implies that progression and levels are problematic notions. Thirdly, when one considers what one learns, the relationships (or arcs) between the facts, concepts, skills or procedures (or nodes) are just as important as the nodes.

Constructivism has implications for learning and teaching and from the work of Ausubel & Robinson (1969), Confrey (1994), Gravemeijer (1994), Lave & Wenger (1991), Salomon & Perkins (1998), von Glasersfeld (1995), and Vygotsky (1978), these include:

- knowledge is personally constructed from experiences, hence a teacher's main role is to fashion pertinent experiences;
- learners' ideas prior to learning affect how they make sense of the teaching they experience, which implies a need for teachers to ascertain such prior knowledge, use *realistic* contexts and respond sensitively;
- cultures and languages of students are important as they relate to prior experiences and while learning is not transmitted by linguistic communication, language in its fullest sense including body language and diagrams is a tool to help students construct knowledge;
- individual constructions should eventually fit with those of the community of practice of mathematicians.

There are also implications for curricula, in particular, that:

- broad learning objectives are preferable to specific behavioural ones because of the way that students build up holistic knowledge schema;
- flexible curriculum and negotiation of it with learners is desirable to ensure that the learning activities enable learners to make links with prior knowledge and realistic and familiar contexts;
- learning activities should encourage *active participation* by learners and not rely on passive transmission modes of interaction, such active participation would enable the learner to relate the learning to prior learning, develop understanding rather than recall and enable the learner to generalize from a specific learning activity.

### ***Enactivism***

In the 1990s I became interested in the biological aspects of learning, particularly the work of Maturana and Varela (1987) and Varela, Thompson and Rosch (1991), the notion of *learning systems*, and the elaboration of constructivism that takes these into account that has been termed enactivism (Davis 1996, Davis & Simmt 2003, Davis, Sumara & Luce-Kapler 2000, Maturana & Varela 1987, Varela 1999).

The notion of a *system* in this study is close to the Concise Oxford Dictionary (Pearsall, 2001, p 1453) definition:

System, a complex whole, a set of things working together as a mechanism or interconnecting network (human or animal body as a whole).

However, living systems and other systems in education are complex rather than mechanistic. Mechanical systems are *complicated*, but they are cause-and-effect

systems where the outcome from certain inputs is very predictable, for example the internal combustion engine, or the system of planets. On the other hand, a complex system is more chaotic and not so predictable.

As an earlier paper (Begg, Davis & Bramald 2003) detailed, enactivism draws on phenomenology (Merleau-Ponty 1962), ecology (Abram 1996; Bateson 1979), and systems and complexity theories (Bateson 1972; Bertalanffy 1968, 1969; Capra 1996; Casti 1994), these being some of the domains that Capra (1996) has described as contributing to *a new scientific understanding of living systems*. In terms of mathematics education, enactivism, together with ideas about living systems, can be considered as an elaboration of radical and social constructivism. They have common views of learning and knowing, as complex, emergent processes by which dynamic agents maintain *fitness* with one another and within dynamic contexts. However, rather than emphasising the individual biological body (as radical constructivists tend to do) or a social corpus (a body of knowledge, or a student body, as social constructivists do), enactivism frames such (knowing) bodies as emerging from and as nested in other complex systems. This move compels attendance to such matters as biologic predisposition as it influences and is influenced by cultural context, which in turn affects and is affected by the emergent environmental circumstances.

Two of the key concepts within this shift in thinking are:

- an enlargement of the notion of cognitive (or learning) systems, and
- the combining together of knowledge, activity and identity.

On the first concept, a *learning system* is any complex form that can adapt itself to changing circumstances. Examples include an immune system as it fights new infections, a stock market as it adjusts to unexpected economic news, an ecosystem as it establishes a new balance when the climate changes, a child who accommodates to the demands of a new classroom and a workplace community that adjusts to expectations from the larger social context. Such systems are generally dynamic and robust. They are able to change and adapt efficiently. However, it needs to be noted that adaptation and change to fit an environment may not be progress. Inherent in this notion is the broader definition of cognition as *coming to know* which includes traditional rational thinking and other forms of learning.

From this perspective *learning* refers to transformations that expand the learner's potential range of action, and it is here that the second major concept fits into place. The suggestion that learning as *transformation* is a reference to the physical character of a learning system. Upon learning, a systems patterns of activity and its associations— internal and external, with and in other systems—undergo physical change. That is, learning affects the entire web of being. It follows that what one knows, what one does, and who or what one is cannot usefully be separated. Capra (1996, p 257) uses the metaphor of a *web* to explain the interrelatedness within and between living systems and says:

In the emerging theory of living systems mind is not a thing, but a process. It is cognition, the process of knowing, and it is identified with the process of life itself. This is the essence of the Santiago theory of cognition, proposed by Humberto Maturana and Francisco Varela.

With this melding of knowing, doing and being, discussions of learning are broadened to include unformulated knowledge or the tacit ground of human activity.

Knowledge is seen not in strictly formal or formulated terms, not as independent of individuals with their environments, nor as something that can be tested or matched against external standards. It is seen as embodied action. Such an ecological perspective locates knowing within a complex web of relations with decisions and actions being both constrained by and influencing all nodes of the web. In rejecting the separation of self from others and knowledge from knower, these ecologically-minded theories emphasize *being connected* which is much stronger than the notion of *making connections* (see Dawson 1999; & Kieren 1995).

From this enactivist perspective, instead of seeing learning as *coming to know*, one envisages learner and learned, knower and known, self and other, as co-evolving and co-implicated. In this situation *context* is neither the setting for a learning activity, nor the place where the student is. The student is literally part of the context. With enactivism the complexity of learning is emphasised. As Davis, Sumara and Kieren (1996, p 153) said:

learning should not be understood in terms of a sequence of actions, but in terms of an ongoing structural dance—a complex choreography—of events which, even in retrospect, cannot be fully disentangled and understood, let alone reproduced.

For me enactivism links with notions of unformulated knowledge (Davis 1996), mindful awareness from more eastern traditions (Batchelor 1998, Krishnamurti 1956, Nhất Hạnh 1987), emotional knowing, and intuition (Atkinson & Claxton 2000; Claxton 1999; Damasio 2000; Goleman 1996), neural biology (Edelman 1987; Plotkin 1998; Varela, Thompson & Rosch 1991), and autopoietic (that is self-regulating and self-maintaining) systems (Maturana & Varela 1980; Mingers 1995). From this perspective I assume that whatever is experienced can be interpreted by

the knower. Whether the experiencing is rational, sensory, or intuitional, and whether the process is conscious and rational, or conscious but with non-judgemental awareness, or subconscious, what a person comes to know is *filtered* and *interpreted* by that person and the filtering and interpreting are influenced by that person's prior experiences and learning. That is, knowledge is always relative to the individual, although the individual's prior experiences will be influenced by their social, historical, cultural and linguistic experience; and as knowledge and knower co-evolve, the person is changed.

These assumptions fit with radical constructivism as well as enactivism, however, I see enactivism as giving more emphasis

- to learning as a complex biological process,
- to the melding of knowing, doing and being, and to living and learning, and
- to other ways of knowing (unformulated knowledge, intuition and mindful awareness).

### ***Other influences***

John Dewey was both a philosopher and an early researcher in education with an experimental school in Chicago where he developed his ideas about what came to be known as *progressive education*. In NZ in the 1940s many parents were concerned about what was called *playway* education. This had been introduced during Beeby's time by people influenced by Dewey's work, (e.g., Dewey 1902, 1916, 1938a).

NZ schools began using projects, morning talks, field trips and other innovations that are still taken for granted now. Dewey saw the teacher's role as *psychologising the*

*subject matter*, that is, constructing experiences through which the child, using natural powers, would make coherent and socially desirable sense (Mason 2006).

Gestalt education (Wertheimer 1980) received more attention in Europe than in NZ but it interested me because it took a stance in opposition to behaviourism. It required one to consider subjects holistically rather than by analysing them into specific objectives and this is reflected in constructivism and enactivism.

Neill of *Summerhill* fame (Neill 1962) in England influenced Anglo-American countries through his pioneering work with the *free school* movement. His ideas were taken up by some private schools in NZ in the 70s, and partially by two state alternative schools (see 5.5) in the 80s. Within the *free school* movement there was recognition of the rights of learners to determine much more about what and how they learn and how the school was organized. The two NZ state alternative schools were closed when government policy shifted to the 'new right' with accountability to the fore and the same criteria used for the accountability of all schools.

The humanist educational ideas of Rogers (1969) link with some of Neill's ideas and have generally not been influential in NZ education. In *Education in Change* (Munro 1969) I saw some evidence of these concerns with the emphasis in the aims of education on engendering self-respect and concern for others; and in one school where I taught (see 5.4) the Principal was influenced by Rogers' ideas. For me the most important notion from Rogers was that learning depends on the learner and the teacher is only a facilitator.



In 1959, three years before I was a teacher education student, I purchased Krishnamurti's (1956) book *Education and the significance of life*. Since then I have repeatedly revisited it. The report by Munro (1969) resonated with me partly because of some phrases from Krishnamurti—*the ignorant man is not the unlearned, but he who does not know himself ...* (p 17); *The purpose of education is to cultivate right relationship, not only between individuals, but also between the individual and society ...* (p. 34); and, *Implicit in right education is the cultivation of freedom and intelligence ...* (p. 33)—which linked with the self, the social and the intellectual. Krishnamurti's ideas were my introduction to spirituality outside institutionalized religion and the possibility of such a dimension in schools.

Learning by observing is not widely discussed and has not reached the status of a theory, although it links with the work on peripheral participation (Lave & Wenger 1991) and authentic learning and apprenticeship (Brown, Collins & Duguid 1989). With the increasing number of Maori and Pacific island students in NZ classrooms and because of my partial knowledge of their traditional ways of learning, I see it as important. Learning by observing fits with theories such as constructivism but changes the teacher's role, with the growing appreciation by ethnomathematicians (D'Ambrosio 1984, Bishop 1988) of different cultural ways of learning, with the idea of connected knowledge (Belenky, Clinchy, Goldberger, & Tarule 1986), and with bodily knowing from enactivism. The notion of observing also links for me with what Mason (2002a) calls *noticing*, with what both Depraz, Varela, & Vermersch (2002) and the Buddhist tradition call *awareness*, and with spiritual ways of knowing which also fits with the worldviews of many Maori and Polynesian people.

### 2.3 Knowing and knowledge—a personal view

From my enactivist perspective I see *coming to know* as happening partly at the conscious level (formulated knowing), but much of it at the sub-conscious level (unformulated knowing); I believe that we are not aware of many things we know. From this perspective one *knows* what *makes sense* and one constantly modifies (accommodates, assimilates, and/or rejects) what one knows as one consciously or subconsciously experiences new things. This process is an evolutionary/ecological process where one's ideas intermittently evolve, usually to make better sense of experiences, although sometimes we fail to learn from experience.

What people know is based on their interpretation of their experiences, and this constitutes *their reality*. As von Glasersfeld said (1983, pp. 50–51),

‘Facts’ as Vico saw long ago, are *made* by us and our way of experiencing, rather than *given* by an independently existing objective world.

This is not to say that reality does not exist, but replaces *knowing reality* by *familiarity with* the mental (or subconscious) image that we create from our experiences. The guiding principle for interpretation is *fit* rather than *truth*, and the *right* ideas are usually based on *fitting* with the view of the dominant *community of practice* concerned with any particular subject.

In terms of unformulated knowledge, aspects such as intuitions, beliefs, assumptions, acts of faith, values and emotions are all forms of tentative knowing where the tentativeness depends on personal interpretation and the coming to know has occurred at a subconscious level.

However, how we come to know does not tell us what knowledge is. For me, if one cannot *know reality* then all knowledge must be approximate, temporary and relative and there can be no such thing as absolute or complete knowledge. (Note that I am not saying that it is impossible to know *reality*—some of the eastern traditions of knowing/awareness through meditation at least suggest one can get closer to something, but getting closer is not knowing.)

I find the work of Hart (2001) provides an interesting way of looking at knowledge. He talks of six interrelated levels (see table 2a) and to these I have added descriptors and my ‘school equivalences’.

Table 2a: *Hart’s levels of ‘knowing’*

<i>Levels</i>	<i>Descriptor</i>	<i>School equivalence</i>
Information	Discrete facts and basic skills	Subject content
Knowledge	Merges experience with information producing systems of information rather than discrete pieces	Subject content including processes and merging with experience
Intelligence	Merging knowledge with life experiences, intuition and analysis and synthesis processes	Subject knowledge in a holistic way merging Hart’s knowledge with unformulated knowledge
Understanding	Intelligence plus empathy, openness, service, and loving (head and heart including seeing things from the points of view of individuals and the community)	Intelligence merged with acceptance of ideas from communities of practice, and acknowledging socio-cultural or community views, also merged more deeply with unformulated knowing including emotional knowing
Wisdom	Understanding plus awareness that enables discrimination	Professed aim of education
Transformation	Wisdom plus ethics for personal and cultural transformation	Ideal aim of education

These levels do not negate the relative nature of knowledge; they suggest a multi-layered way of considering what has traditionally been called knowledge. Hart's ideas *resonate* with me, they *make sense*, they *fit* with my thinking. They imply a multi-connected schema. His levels imply that to stop with facts and procedures, as is often done in schools, is inadequate. I believe that with learning we are always aiming at least for wisdom in the long run.

In discussing knowledge it is important to consider influences that vary across cultures. The *container* metaphor dominates Western thinking (including mine) and means that mutually exclusive categories are used to *sort* ideas, for example, true or false. But Smith (2003, p xv) cited Ted Aoki as saying, *Neither this nor that, but this and that*, and such thinking suggests the *yin-yang* of eastern thought with opposites not as categories but as mutually constituting inseparable aspects.

With behaviourism, knowledge is regarded as objective and existing in the material world. With constructivism knowledge is viewed as a human construction, evaluated in terms of *fitting* with the experience of the knower, and is thought of as being located in the mind. Davis (1996) claims the need to locate knowledge is because it is seen as *something*. Bateson (1972) provided an alternative to this by envisaging information not as *knowledge-as-object* but as *knowledge-as-action*, that is, information is what happens when data informs action. This emphasis on action fits with the way Davis (1996) sees knowledge when he says that in enactivism collective action is not for individual sense-making but as a *location* for shared meanings and understanding.

Two other aspects of knowing that I see as part of enactivism but which I ignored in the past (and I believe are often ignored by others, perhaps especially teachers in subjects other than the arts and humanities) are the emotional and spiritual aspects of knowing. I agree with the argument of Goleman (1996), that emotion has a role in shaping our perceptions in all aspects of learning and this notion is developed further in 11.3. Being sympathetic to the role of emotion implies for me that as teachers there is a need to develop empathy for learners, and *hermeneutic listening* (Davis 1996, p 53) seems one way forward. This is more than interpretive listening (see 11.3), as Davis says (p 168)

The critical point here is that hermeneutic listening implies more than a different mode of attending. It is a different mode of relating, of being in a relationship, that implicates listener and listened to.

The second aspect is the spiritual. Maslow (1964) is probably the first writer to bring *spiritual* experience from religion to mainstream (and transpersonal) psychology. Spirituality can be seen as independent of organized religion (Gollnick 2005) and this is how I see it. Divergence of spirituality and religion was noted by authors such as Naisbitt and Aburdene (1990) who discussed traditional church membership and 'new age' interests in the United States of America. Separation also fits with Buddhist and Taoist traditions that do not have a god-concept as such. The spiritual aspect of knowing means appreciating knowing through *awareness*, a non-judgemental knowing, usually developed through meditative practice, where the *learner* is still and is *being* rather than *thinking*. Such a way of knowing may not seem to have immediate relevance for teaching mathematics, but for me all learners need quiet reflective time, not merely to reflect in an active way, but also just to be and to develop their awareness of many things including their *thoughts*. In this I am

influenced by the traditions of *mindfulness* from the Buddhist monk Nhat Hahn (1987), the educator Langer (1989, 1997, 2005), and the medical worker Kabat-Zinn (1994, 2005). This is not only a NZ problem— Donaldson (1992) sees the *value-sensing* way of knowing as important but neglected in the UK, and sees discursive thinking as getting in the way of such an intuitive, value-sensing way of knowing.

My thinking on learning and teaching shifted quite dramatically as I was challenged by new theories, my notions about the nature of mathematics have evolved more gently. New ideas enriched my views of mathematics, but were not contradictory.

## **2.4 Thinking about mathematics**

Mathematics always seemed purposeful to me. It was developed to *model* or to *make mathematical sense* of the material world, and, since Plato, to make sense of the philosophical world of experience. While every subject provides a way of making sense of the world, mathematics is different from others in that it is, or at least has become, axiomatic. In 1954, my first year of high school, I learnt about and accepted that certain assumptions (axioms) are made, stated, and assumed to be *true* within any branch of mathematics, and that a mathematical statement's truth or falsity depends on the axioms and the logic used. I learnt that different axioms are possible and different mathematical systems result accordingly— for example Euclidean and non-Euclidean geometry, and traditional and Boolean algebra. When working within a specific set of axioms the axioms may be taken for granted rather than be stated, the logic system is usually the Western one, and the people involved often disregard the relative nature of 'truth' in their work.

However, accepting the relative nature of mathematical knowledge, the problem remained. In *What is mathematics?* Davis & Hersh (1981, p7) began answering this with a definition from a dictionary *mathematics is the science of quantity and space*, but suggest that while this definition *has a historical basis*, it needs amplifying *in a way that reflects the growth of the subject over the past several centuries ...*. They go on to discuss a number of ideas that generally are associated with mathematics—symbols, abstraction, generalization, formalization, mathematical objects and structures, proof, and so on (Davis & Hersh 1981, pp.122–157). They also discuss the question of whether applied mathematics is mathematics, and whether applied mathematicians are mathematicians or users of mathematics; and within applied mathematics they include: physics and engineering (p 44), statistics and computing (p 86) and business, commerce, and war, and historically, mysticism, astrology, and religion (p 89), and of course teachers.

In my experience most people think, as Mason (2002b) said, *mathematics is what mathematicians do*. But, mathematics is constantly evolving and expanding and this makes it difficult to define. I assume that readers were aware of the variety of topics and developments within the subject as they progressed within schooling, and some, whether through further study or related experiences beyond school, are aware that the boundaries of mathematics keep shifting. However, many people see mathematics as school mathematics, as a series of facts and procedures, often not understood. They have not been exposed to new developments and do not see mathematics as evolving, perhaps because they only have access to a limited and circumscribed portion.

School mathematics can be thought of as a subset of mathematics. In NZ it includes statistics, and the curriculum suggests that applications should be used throughout, thus conceiving of it as a meld of pure and applied mathematics and statistics. It has changed considerably during my years in education (see table 1a) although most students (present and past, except for parents helping their children) see school mathematics as the mathematics they learnt at school. During my schooling and while I was teaching, mathematics was seen by most people as a content-focussed subject where facts and procedures had to be learnt so that correct answers to routine assessment tasks could be obtained. When *applications* were used they were usually in the last exercise on a topic. Often they were simply word problems based on the topic that had just been taught, and the intent seemed to be to show the usefulness of the subject and to give more practice, rather than to provide scaffolding for learning by providing concrete contexts. It does seem to me that more consideration needs to be given to applications, I agree with the general argument, put forward by Gadamer (1988, pp. 307–311), who argues that knowing has three components: understanding, interpretation, and application. Thus, I see applications (applied mathematics) as an essential part of mathematics. An alternative way of looking at knowing in this broad way was summarised by Mason & Johnston-Wilder (2004, p 293):

*Knowing-to act in the moment using a particular action or strategy is more sophisticated than knowing-that something is true or knowing-how to do something when asked, and more demanding than knowing-when and knowing-about or even knowing why. All the forms of knowing are involved in understanding ...*

From their perspective *knowing-that* is factual knowing, *knowing-how* is explicit procedural knowing, *knowing-when* is knowing theoretically, *knowing-about* is generally ‘informed’, while *knowing-to* involves action, to act in the moment.



In NZ, until the end of the 1970s there was more emphasis on logic than there is currently, this was initially embedded in the traditional approach to Euclidean geometry, and again within the logic and structure approach to *new* mathematics when it began in the 1960s. The decrease in explicit logic at the high school level seemed to me to be due to the increased percentage of students staying on at school, and teachers making the subject less rigorous as a means of coping with this larger range of student ability.

In the past in NZ schools there was some emphasis on problem solving, but usually on word problems, and nearly always within a topic so the method to be used was obvious. Problem solving as discussed by Pólya (1957), and later the mathematical processes in the USA's 'Standards' documents (National Council of Teachers of Mathematics 1989), contributed to a change in emphasis on problem solving in particular and from content to process within NZ's curriculum document *Mathematics in the New Zealand Curriculum* (Ministry of Education 1992). As this curriculum has been implemented the processes have been recognised within school mathematics—these being, reasoning, problem solving, communicating, and implicitly making connections and using tools. However, the influence of assessment, which some might see as something done to curriculum, but I see as a level of curriculum, has meant that these processes have not always been given the intended emphasis in lessons.

In the current round of curriculum review in NZ, there is an increasing emphasis on thinking across all curriculum areas including mathematics. This fits with what

Dewey (1916) argued strongly for, and I would doubt if many people including teachers, would disagree that thinking is a central issue in education. However, *thinking mathematically*, or *thinking in any subject* is often narrowly interpreted, perhaps because there has been little written in school textbooks to make thinking explicit or to suggest the specific contributions to thinking that each subject can make. As a consequence of this school mathematics for many children is likely to continue to be the learning of *set pieces* rather than learning to think mathematically for some time.

My view of mathematics (and school mathematics) is as an integrated subject with three interrelated and overlapping aspects that reflect knowing, doing, and thinking, as represented in figure 2c. The detail within these aspects being listed in table 2b.

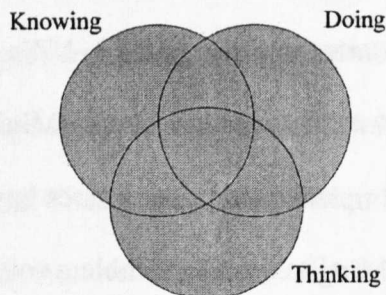


Figure 2c: *Three aspects of mathematics.*

Table 2b: *Details within the three aspects of school mathematics*

ASPECTS	DETAILS		
<b>Knowing</b> (content)	Arithmetic (number)	Geometry (& measurement)	Algebra
	Statistics (& probability)	Trigonometry	Calculus
<b>Doing</b> (Processes)	Reasoning	Problem solving (& posing)	Communicating
	Making connections	Using technology	Moving between representations
<b>Thinking</b>	Critical	Creative	Metacognitive
	Generalizing/specialising	...	

I have no difficulty with the argument that this categorisation into three aspects is artificial as the boundaries between knowing, doing, and thinking are fuzzy and may not be useful. However, the categorisation emphasizes the shift to processes in the 1990s, and the change that I believe is now important, namely to emphasize thinking.

In discussing the nature of mathematics I see a need to consider other perspectives. Logic and proof are important in western/academic mathematics. At a pragmatic level solving problems accurately might be the focus as it is in Vedic mathematical traditions. In addition, within some Indian traditions mathematics is considered from a recreational perspective (Joseph c1995), and similar aspects seem apparent in other traditions (e.g. Chinese and Babylonian) where there is evidence of magic squares and other such artefacts. Seeing mathematics as a separate subject is part of a western partitioning of knowledge whereas some other cultures see knowledge in a holistic way with mathematics embedded where it is useful. Thus it seems desirable in increasingly multicultural countries such as NZ, that further exploration be encouraged to find different cultural views of mathematics and to organise school mathematics in a way that better fits these views.

The place of statistics within mathematics is problematic. At tertiary level statistics education has flourished and many statistics departments have been formed outside mathematics departments. At school level, in a recent UK report, Smith (2004) recommended that statistics not be taught within mathematics, and fearing the way that educational fads spread, this may not bode well for the future within NZ. Because statistics is well established within mathematics in NZ schools such a

change may be unlikely to occur, but if it did I would be concerned that statistics would cease to be taught at schools in spite of it being such a useful part of the mathematical sciences for everyday life and work. However, the differences between statistics and mathematics need acknowledgement—statistics begins with data-sets and with variation and is concerned about reasoning in uncertain situations while mathematical reasoning is based on *relative* certainty (with axioms). However these differences are becoming blurred as the study of chaotic systems and chaotic environments become accepted within mathematics.

## 2.5 Considering complexity and systems

Chaos, complexity, systems theory, and systems thinking are relevant to this study because I now envisage learning in terms of learning systems. For me learning systems include education systems and social systems and are living systems. I have found systems thinking a useful way of looking at schools, classrooms, educational bureaucracies, educational development, curriculum and mathematics. Capra (1996, p 29) has written about complex systems and systems thinking. He sees systems thinking as originating with ideas from organismic biologists and relating particularly to the three notions—*connectedness, relationships, context*. He sees the essential properties of complex and living systems as *properties of the whole, which none of the parts have*, and sees these as arising *from the interactions and relationships between the parts*. For Capra the emergence of systems thinking was a *profound revolution in the history of Western scientific thought* that broke from the Cartesian view that *the behaviour of the whole can be understood entirely from the properties of its parts*. Examples of such complex systems include ecosystems and

biological systems (Bertalanffy 1940, 1969). Chardin (1955) discusses humans and the world in terms of complexity and systems (pp 47 & 48), but the notion of humans as complex living and learning systems comes from Maturana & Varela (1987).

Capra (1996, p 95) writes about Maturana's struggle to distinguish between living and nonliving systems, and to answer the questions, *What is the organization of the living?* and *What takes place in the phenomenon of perception?* (Maturana, from Maturana & Varela 1980). Maturana identified the processes of living and cognition as the same, he said (Maturana 1970), *Living systems are cognitive systems, and living as a process is a process of cognition.* To describe the circular organizing principle behind such a system Maturana and Varela invented the word *autopoiesis* which means self-making (Capra 1996, p 97) so autopoietic systems are complex systems that are self-making, self-organizing, self-regulating and self-maintaining systems. Thus, humans are autopoietic systems with nervous systems structurally coupled to bodies and through this to the environment (Mingers 1995). From this perspective *the body and the nervous system are structure-determined systems; the changes they undergo depend on their own prior structure and can only be triggered, not determined, by interactions with other systems* (Mingers 1995). In this study the most important autopoietic living systems are learning systems which were introduced in 2.2 under the sub-heading enactivism.

Traditional western dichotomous thinking that assumes an *either/or* stance is not always adequate when thinking about systems and complexity, one needs eastern logic where the alternatives might be thought of as, *either/or/both-and/neither*. And,

from a systems perspective, while levels, stages and hierarchies (such as Hart's levels, table 2a) are useful to extend thinking they are not always appropriate. Thus, classifications such as:

- enactive/iconic/symbolic (Bruner 1966 pp 44-45);
- play [exploratory-manipulative, representational, and search for regularities], and logic [classifications, generalizations, logical classifications, and deductions] (Dienes 1963);
- visualisation, analysis, abstraction, deduction, and rigour (van Hiele, see Crowley 1987);
- sensory-motor, pre-operational, concrete-operational, and formal-operational (Piaget, see Mason & Johnston-Wilder 2004, p 162);

might more appropriately be thought of as complexly interconnected phases rather than levels because learners may move from one to another without moving through the sequence, and coming-to-know (be it conscious or sub-conscious, rational, emotional, or spiritual) results from complex interactions between learners and their environments. Stable trajectories through identified stages fail to capture or account for autopoietic co-emergent complexity.

## **2.6 Making curriculum complex**

In chapter one I defined curriculum as *all planned activity for the classroom*. This implies that curriculum is dynamic as planning is always occurring at one level or another, even in the midst of teaching as teachers respond to classroom situations. I now see curriculum as a complex living system in which teachers and others are implicated and the system responds to interactions within the total system.

When Maturana and Varela introduced the *autopoietic systems* they claimed that the parts of the system are *structurally coupled*. For them, this property established the difference between the way living and non-living systems interact with their environments. For example:

... when you kick a stone, it will react to the kick according to a linear chain of cause and effect. Its behavior can be calculated by applying the basic laws of Newtonian mechanics. When you kick a dog, the situation is quite different. The dog will respond with structural changes according to its own nature and (nonlinear) pattern of organization. The resulting behavior is generally unpredictable. ... As a living organism responds to environmental influences with structural changes, these changes will in turn alter its future behavior. In other words, a structurally coupled system is a learning system. ... As it keeps interacting with its environment, a living organism will undergo a sequence of structural changes, and over time it will form its own individual pathway of structural coupling (Capra 2002, pp. 35–36).

If I replace *dog* with *curriculum* and *kick* with *nudge from someone who wants to change the curriculum*, for example, a mathematician who wants set theory introduced, a statistician who wants more statistics, or a bureaucrat who wants more assessment, then we have a complex learning/living system. In this situation *living* has an extended meaning, and learning includes evolving without consciously being aware of change as well as learning in the traditional sense.

Such a view is very different from the notion of curriculum as a Newtonian or mechanical system or machine-like organization. Paraphrasing some sentences from Wheatley (1992, p 28–29, 32) with the word curriculum replacing world:

A curriculum based on machine images is a curriculum filled with boundaries. ... These omnipresent boundaries create a strong sense of solidity, of structures that secure things, a kind of safety. ... Boundaries also create a strong sense of identity. They make it possible to know the difference between one thing and another. ... In this curriculum there are well defined edges; it is possible to tell where one stops and the other begins, ... When the curriculum ceased to be a machine, when we began to recognize its dynamic, living qualities, many familiar aspects of it disappeared.

Society is a self-producing or autopoietic system of communications (Luhmann 1995/1984). While such communication (feedback or interaction) within a system is

important, communication itself is a system—it involves interacting components, and we know from classrooms that such systems are not mechanical. Schools and classes have been described as knowledge-exchange systems, social systems (or sub-systems) and as open systems. A class is a system open to its environment, the school system; the school in turn is open to the educational system, which is open to society. Change in terms of curriculum, resources, assessment and professional development is an open system or a series of subsystems with interactions from the environment. If curriculum is thought of as a document, then it is a closed system, but if it is what is planned and implemented with children then it is a living/learning system. Further, the model for educational development including for curriculum that I now see as explaining development (see 10.2) is a system model.

In the early stages of my life including when I was teaching my view of what constitutes *all planned activity for the classroom* was quite limited. This study shows how my interpretation of this definition changed, in particular when I developed a systems perspective, and that is part of how curriculum is emerging for me.



## Chapter 3 Reaching a research stance

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### 3.1 Backgrounding this study

When structuring this study I reflected on my earlier research efforts:

- At school, a 40-page project on *Canada*, *How a one-valve radio works*, and an extended essay on *George Orwell*. These projects involved reviewing literature and talking to people.
- At undergraduate level (1959–1969) studying mathematics, science, education and commerce I did no research. If I had it would have been a positivist study using statistics, summarizing data and testing hypotheses.
- As a teacher and textbook author my only research involved finding good learning tasks and making informal judgements about them.
- In curriculum division I surveyed teachers using two questionnaires; an open-ended questionnaire to find a range of possible responses, and a multi-choice one so that responses could be summarized statistically.
- At university in the 1990s my first major project was a qualitative one with a significant literature review and involving interviews and observations that

were not statistically analysed but used to show the range of experiences teachers encountered.

- Another project completed (though not fully documented) at university involved comparing curricula from other countries (see chapter 9). This was a personal exploration of possibilities involving scholarship and interviews.

The design of this research project arose from my aims. I sought:

- to get my work-to-date into perspective,
- to share my experiences and thoughts on curriculum to help legitimate the view that there are many ways of envisaging curriculum, and that these change over time,
- to stimulate debate on curriculum by encouraging others to reflect on their present views, to consider other possibilities and to appreciate the many ways in which curriculum can be conceptualised.

From such debates I hope that a range of new ideas will emerge and colleagues will find their resolve strengthened to experiment with alternatives.

While numerous researchers believe that the main purpose of educational research is to inform policy making and professional practice, I subscribe to an alternative view as held by others such as Mason (1998) who wrote:

the most significant products are the transformations in the being of the researchers  
and

the second most significant products are stimuli to other researchers and teachers to test out conjectures for themselves in their own context.

These purposes fitted with my aims and I decided that they could be achieved using an autobiographic narrative that I hoped would appeal to my intended audience. This audience being people from a wide age range in similar positions to those I have been in (teacher, textbook co-author, curriculum developer, and tertiary educator).

This decision was reinforced for me when I read Walker (2005, p. 223):

It is from our stories that we will remake the world. ...  
Also, there is an easy distrust of "information." There is too much of it.  
Knowledge supplies the facts; stories give sensation to the heart.

This sums up my feelings. My hope is to communicate with readers, not merely provide information, but appeal to their minds and hearts.

Having decided to use autobiography, I considered how I might select, organize and report relevant events from my history. I decided to use *incidents* that would be described, interpreted, and reflected upon with hindsight. I saw these incidents as the phenomena and the interpretation as hermeneutics, thus, the study fits a framework of hermeneutic phenomenology. I thought about how to collect my data, and to ensure that it was *quality* data (whatever quality might mean—see 3.6). Finally I considered how the researcher influences the research, and with autobiographic research the researcher and research are inseparable, so there was a need to discuss my influence on the study. The remainder of this chapter addresses these issues.

Usually a researcher starts with a literature review but this does not seem appropriate with autobiography. I had read considerable literature during my career and this emerges as I discuss my work. Although my research is on curriculum I have not gone deeply into the literature of curriculum theorists because my focus has been on curriculum as it relates to teacher-practice and to government-policy.

### 3.2 Signifying incidents

In writing this autobiography, I needed to select *incidents*. I began by thinking of them as *significant incidents*, and wondered if Tripp's term (1993) *critical incidents* might be more appropriate. However, I questioned if the ones coming to mind were either critical or significant. With notions of complexity in my mind it was difficult to identify incidents as critical or significant, yet to me they were meaningful and seemed to signify change. The term *signifying incidents* therefore seemed appropriate as this discriminated between the particular incidents and the many mundane ones from my life. As I have not included the mundane ones I refer to those used simply as *incidents*.

These incidents are designated by a heading, and italicised. After each I have included what I believe to be my immediate thoughts, interpretations and reflections on the incident. Further insets indicate later reflections made with hindsight.

I am aware that in isolating an incident such as a moment of pedagogical activity, I am separating the event from the people involved and the event from what happened before and after. I see an event, the people involved, and the context as inseparable, and I can never be sure that the learning occurred at the time of the incident or later as a result of it. Looking back also means that some details are forgotten and that compromises are made by necessity. I knew I had not observed and listened to everything; nor could I recall everything. I could not possibly build a complete version of what Tripp (1993) called a critical incident file.

However, Tripp made four points that are relevant for signifying incidents:

- i Incidents happen all the time, which are *signifying* for one's development is a personal decision.
- ii To say an incident is *signifying* is to put a value on it and, attach meaning to it, and reflect on it.
- iii *Signifying* incidents are not usually dramatic or obvious, they are commonplace and occur as part of routine professional practice, but the identified ones are indicative of trends, motives, and structures that are personally relevant.
- iv Having called an incident *signifying* and recorded it, one must reflect on it with a professional awareness and sensitivity and not merely in the everyday way of looking at things, that is, there is a need to describe the incident (the *what*), then to explain it (the *why*).

Tripp's approach has many similarities to that of Mason (2002a) in the *discipline of noticing*. *Noticing* is usually an informal word for observation and/or listening but Mason uses the word in the context of practitioner research with a deeper meaning. He talks of the *discipline of noticing* in terms of developing sensitivity and awareness within professional practice, and as *a collection of practices both for living in, and hence learning from, experience, and for informing future practice* (p. 29). This discipline involves *intentional* noticing that distinguishes foreground from background. It involves *marking* which enables one to recall an incident, and re-mark about it. Recording is part of making a mental note of the incident. In recording an incident Mason differentiates between an account-of and accounting-for. The first describes the phenomena with a minimum of judgement, evaluation, or

justification; the second involves interpretation of it. He suggests that an account-of should be brief and vivid. Brevity being obtained by omitting details that divert from the main issue, and vividness by sticking to a factual description of behaviours that others would or could have also observed. The next stage of the discipline of noticing is probing the accounts, or as many researchers refer to it, interrogating the data. This involves developing sensitivities to alternative interpretations, to recognising future choices, and noticing in the moment in such a way that connections are made and alternative possibilities emerge. Thus *noticing* provides an approach to using accounts (or incidents) that arise within any method to effectively inform future practice.

These ideas from Tripp and Mason fit well with my view of phenomenological research. The common elements are description, interpretation, and critique. Such critique implies, amongst other things, making meaning and questioning assumptions, and this often occurs with the benefit of hindsight.

In presenting my incidents I have not used real names or pseudonyms. This is to preserve privacy; these are my descriptions and my interpretations of the actions or words of others, and may not reflect how the other participants see the incident.

### **3.3 Interpreting phenomena**

For me *interpreting* means *understanding some meaning or significance*. What is interpreted are *phenomena* which are *situations that are observed to have happened but usually have some elements of repeatability or similarity with other phenomena*.

Van Manen (1990, p 5) says that to research from a phenomenological perspectives is, *to question the way we experience the world, to want to know the world in which we live as human beings*. Hermeneutics began as the interpretation of biblical texts but is now used more widely as *the art of interpretation* (Davis 1996, p 18). Thus, in that I am describing and interpreting phenomena in this study, my framework for the research is based on hermeneutic phenomenology. However, the words hermeneutic and phenomenology have deeper meanings. As I understand them, hermeneutics has overtones of looking for different meanings so that we can think differently about ourselves and question the traditional or surface meaning, while phenomenology has overtones of describing experiences from (as far as possible) a pre-suppositional stance. This meaning for hermeneutics fits with my aim of stimulating debate. However, I have difficulty with the pre-suppositional stance for descriptions of incidents because *the describer is in fact part of the description* (Mason 2002a, p 236) and a describer always comes to a situation with prior experiences/learning that influence how what is seen or heard is understood. My concerns were somewhat alleviated when I read:

The methodology of phenomenology posits an approach towards research that aims at being presuppositionless ... tries to ward off any tendency towards constructing a predetermined set of fixed procedures, techniques and concepts that would rule govern the research project. (Van Manen 1990, p 29)

I was pleased to see that Van Manen had said *aims* at being presuppositionless. Thus my aim became to minimise presupposition while acknowledging that what is noticed is always observer/describer dependent.

While my approach generally fitted with the description of *hermeneutic phenomenology* from van Manen (1990), he gives a warning (p 18):

... its fundamental fascination. To do hermeneutic phenomenology is to attempt to accomplish the impossible: to construct a full interpretative description of some aspect of the lifeworld, and yet to remain aware that lived life is always more complex than any explication of meaning can reveal.

Heeding Eco (1992), who warns of the problems of over-interpretation, I wondered, how to guard against over-interpreting the *text* of my life. I tried to keep before me the question—am I imputing an interpretation to an incident when the interpretation may be of the incident with other associated ones? Perhaps the notion of *signifying* as a descriptor for incidents excuses such extended interpretation.

I found Van Manen's work useful when looking at hermeneutic phenomenology as he writes about it in the context of autobiography. He said (1990, p 23) *phenomenology does not solve problems, but asks meaning questions*, and this fits with my quest where the question *what curriculum means and is coming to mean?* is a meaning questions that this study attempts to address. In addition, he acknowledged (1990, p 33) that in phenomenological research there is the need to remain strong in one's *orientation to the fundamental question or notion*. That is, to not be *side-tracked* nor *settle for preconceived opinions or conceptions*. However, my focus on curriculum is a very broad one. Some side-tracks have seemed relevant to me and my preconceived opinions and conceptions are difficult to ignore since they were formed as part of my lived experience and are sometimes difficult to separate from pre-reflective consciousness of past experiences. Perhaps sometimes readers may feel that I have not remained as *strong* as would have been ideal.



### 3.4 Writing autobiography

Early in my teaching career I had read the two autobiographical works by Ashton-Warner (1963, 1972). These had influenced a number of teachers and demonstrated to me the power and value of autobiographic writing. Two other influential books were by Neill (1962) and Mann (1987); these have been read by some as being about schools, but I read them both as autobiographical accounts involving the authors' personal philosophies, and their resulting actions in organizing their schools and curriculum. All four books involved considerable reflection by the authors and I assumed this had been accompanied by personal growth for the person reflecting. They also provided stimuli for the reader. For me these two attributes, personal growth and stimulus for others, are fundamental properties of good research. But still I wondered about autobiography and asked myself *is writing autobiography research?*

I usually interpret the term *research* quite widely, and had vaguely assumed that it included autobiographic writing, and this was confirmed for me as I read the works of Van Manen (1990, 2002), Hatch & Wisniewski (1995), Moustakas (1990), and Clandinin & Connelly (2000). According to Chalmers (2004, p 15), autobiographical studies are comparatively common in art education, but I had not encountered any in mathematics education and that spurred me on. As Raunft (2001, p. xii) has said :

Autobiographies, through their narrative emplotments and reflections of the authors, give order and meaning to life and are different than experience. A specific autobiography ... has specific focus, range and limitations, yet reflects the uniqueness of each lecturer with regard to their personal and professional lives. With every autobiography, we see an author's self-awareness being structured into some order that mediates between subjective and objective reality. The question of reality forces the reader or researcher to look at an autobiography in the context of memory and self ...

Research is always based on a researcher's perspectives and experiences, and with autobiography this is even more so. My challenge was to ensure that descriptions of experiences, their contexts, and interpretations of them, satisfy appropriate quality criteria (see 3.6). Even then there were difficulties; autobiography is multi-layered with connections between layers and writing a complete autobiography is impossible. One can only present a view of the connections that one is aware of as a result of writing and pondering, and this awareness is a result of subjective interpretation as pondering and writing are influenced by hindsight. Additionally, the connections between layers are virtually limitless and thus one can only write an autobiography with an emphasis on particular themes. However, one cannot always stay within such recurring themes, other aspects of one's life have an influence, thus my story also moves beyond formal educational environments. This seems reasonable because knower and known, in this case researcher and researched, are inseparable and instead of looking beyond myself for causes and solutions to challenges or problems I see myself as part of them.

My story is a way of knowing, it is an individually and contextually situated story, as such it is life history or narrative (Hatch & Wisniewski 1995), and it links experience and story (Clandinin & Connelly 2000). It is personal and subjective, yet hopefully also practical in terms of stimulating *resonance* and *debate*. Considering narrative, Greene (1995, p 1) used the phrase *narrative in the making* and wrote of *writing in terms of stages in a quest*. This reflects what I am doing in reviewing my work-to-date and in trying to stimulate debate—these aims suggest a quest or a journey and not a destination. Greene reflected on how she had had different roles at

different stages of her life and said that *neither my self nor my narrative can have, therefore, a single strand* (p 1), and how *I hope to connect my own seeking with the strivings of other teachers and teacher educators ...* (p 2); and both these statements have parallels with my situation.

I saw autobiographical narrative from a constructivist or post-modernist perspective. As Heikkinen (2002, p. 17) suggests, this results in *some kind of authentic view of reality, although the belief in the potential attainment of an objective reality is rejected*. But this does not negate the value of autobiography; as Meriläinen & Syrjälä (2002, p. 159) wrote in the same volume,

... writing ... can be seen as a means of thinking. ... (it) allows the writer to rethink and revise ideas over an extended period. ... Writing is considered one of the most effective methods for collecting autobiographical data.

With these thoughts in mind and having accepted that autobiography is research, I began. Autobiography usually follows a one-direction time scale. In organizing my story I have occasionally moved from this. The overall story moves through my main work situations in order, but within each I have organized incidents within recurring themes, and with some aspects of my life reported in series rather than in parallel.

### **3.5 Collecting data**

Ideally an autobiography draws on data from journals kept for the years to which the study pertains, but I had not kept journals during my career. Consequently I had to rely on my memories of events and reflections on these memories, and I acknowledge the selectivity of memory. I *mined* my memory banks to recall the

changing views of curriculum that I have undergone throughout life and sought incidents that seemed to signify these changes of viewpoint. This *mining* was done by conscious recall, occasional moments of spontaneous recall, quiet reflection, talking with others and re-reading my professional and academic writings that I had retained from throughout my career. This re-collective/reflective/interpretive approach to research has been time consuming but more personally fulfilling than approaches I had used doing research in the past.

I began with a time line, slowly amassed a large collection of incidents that had occurred, then filtered these for relevance. Some incidents were initially forgotten yet over the five years of this study I recalled them.

One paper was particularly significant for me. I had been invited to give a conference keynote address (Begg 2000a) and had spent months reflecting on my past and trawling through previous papers to prepare it. This process developed my interest in autobiographic research and was a starting point for this study.

With few formal records, and fallible memory banks, I hope the incidents are reported with fidelity. Some minor details might be incorrect, but even if they are post-incident re-constructions of the past they are meaningful to me, and reflect incidents of the time. If any incidents are simulations rather than reports of what occurred then readers may still resonate with them as they are my attempts to closely re-present incidents. As with descriptions of incidents, I hope that interpretations of incidents are neither post-incident rationalisations nor old-age self enhancement.

### 3.6 Ensuring quality

Truth is the traditional criterion for quality research, and as far as possible I have checked what I think I thought with papers written at the time and with colleagues, but memory is a living and evolving system. An alternative criterion is *fidelity*; as Grumet (1988, p 66) said regarding autobiographical research, *Fidelity rather than truth is the measure of these tales* and in this distinction said, truth is *what happened in a situation* while fidelity is *what it means to the teller of the tale*, (or perhaps, what others would or could recognise).

In using Grumet's concept of *fidelity* as a quality criterion for autobiographical research I accept that the criterion is subjective because the researcher/autobiographer determines meaning for themselves. This property is accepted by others, for example, Blumenfeld-Jones (1995) said *truth treats a situation as objective while fidelity is subjective* (p 26), and writing about narrative research Heikkinen (2002, p 17) rejected objectivity and said.

Research from this perspective, perhaps has an ability to produce some kind of authentic view of reality, although the belief in the potential attainment of an objective reality is rejected.

In this situation, rather than thinking of truth, validity or reliability, Heikkinen uses the term *verisimilitude* (having the appearance of truth, and being very probable) and suggests (p 25) that

... when a narrative is verisimilitudinal, the question of whether the events actually happened in some real place to some real individual is not so important. ... Simulation as a criteria of truth does not, however, mean that reality is excluded from narrativity. Quite the contrary: reality is precisely included in a simulation.

In a somewhat similar vein, Moustakas (1990, p 32) asked,

does the ultimate depiction of the experience derived from one's own rigorous, exhaustive self-searching and from the explications of others present comprehensively, vividly, and accurately the meanings and essences of the experience?

Moustakas went on to say that this judgement must always be subjective and can only be made by the researcher. These comments for me fit with the notion of *resonance* that Mason (2002a, pp. 191–192) discusses with respect to noticing, and with his statement (Mason 2005) that, *much vaunted objectivity can be found through careful subjectivity in which accounts are offered that refrain from judgement but seek resonance in other people's experience.*

The traditional quality constructs or quality criteria in research are reliability, validity, and generalizability. Lincoln and Guba (1985) reject these for qualitative research. They suggest instead that one can establish the trustworthiness of data using criteria such as credibility, transferability, dependability and confirmability. Credibility (comparable to internal validity) requires the researcher to show that the subject of the enquiry was accurately identified and described. Transferability (instead of generalizability) is the ability for another to recognize the interpretation as speaking to their own situation. Dependability links with credibility and is usually achieved by triangulation to ensure that bias is limited. Confirmability (as opposed to objectivity) is ensured by providing enough evidence to justify the approach and the connections with the data and conclusions.

I have trouble with these four criteria. Credibility in terms of an accurate identification and description of the subject is problematic because of the personally constructed nature of my study and my acknowledgement that alternative

constructions of a subject are always possible. Transferability is unlikely to be possible because the study is done in a situation that is specific in terms of culture, historical period, and the people involved. Dependability usually relies on triangulation but this account is my personal interpretation, not that of others, and I assume that others could well have constructed somewhat different realities from the same experiences. Finally confirmability, like credibility and dependability, ignores the notion of personal interpretation in the construction of knowledge.

The best I hope for in terms of credibility, transferability, and dependability are *fidelity* and *resonance*. By this I mean that I hope this study provides the reader with stimuli that stir memories and cause alternatives to be considered in ways so that the reader comes to understand how others see curriculum differently.

Related quality criteria include: relevant and authentic, meaningful and useful, trustworthy and honest, and then with the research report, coherent and lucid. These too are subjective—I see them as being satisfied, but a reader may feel otherwise.

Bruner (1996, p 90–91) wrote about *the interpretive turn* in education, and that,

... the object of interpretation is understanding, not explanation.  
... understanding, unlike explaining, is not pre-emptive ... (and)  
... nor does the interpretation of any particular narrative rule out other interpretations.

He went on to ask,

what standards can competing narratives or competing interpretations of a narrative be adjudged as “right” or “acceptable”? For one thing, alternatives may derive from different perspectives. But that surely is not enough: some narratives about “what happened” are simply righter, not just because they are better rooted in factuality, but also because they are better contextualised, rhetorically more “fair-minded,” and so on. But what is even more crucial, alternative narrative accounts may show comparable awareness of the requirements of narrative itself.

As Van Manen (1990, p 31) put it,

A phenomenological description is always *one* interpretation, and no single interpretation of human experience will ever exhaust the possibility of yet another complementary, or even potentially *richer* or *deeper* description

Bruner's analysis (1990, p 17) reminded me of *ego defense and rationalization* as an explanation.

From these notions two questions arose for me, Firstly *Is autobiographical narrative real or imaginary?* and secondly, *Does that matter?* I acknowledge that neither a historian's view nor that of a novelist is *true*, though I assume that from a *mathematical* perspective, my accounts represent reasonable approximations. I see writing narrative as reporting, reinterpreting and reconstructing what seems to me to be my past, and my story is therefore not a record of what I did, but rather a record of what I think now that I did; and that is the best that I can do. In particular, the incidents I report may be causal, correlative, or co-incidental to my changing views about curriculum, learning and mathematics but for me they are related. I am not trying to find causes—with my systems view I accept that I can only say that incidents might be influential.

In spite of these doubts about quality criteria I continue writing and find comfort in Van Manen's notion (1990, p 27) of *the validating circle of inquiry*, he says that,

a good phenomenological description is collected by lived experience and recollects lived experience—is validated by lived experience and it validates lived experience."



### 3.7 Revealing myself

I occasionally use the word *story* rather than *autobiography* to acknowledge an aspect of story-telling that intrigues me—how incidents are chosen. When researching myself, how do I reconstruct my reality? Which incidents have I forgotten? Which do I choose or reject when life is complex and incidents are intertwined? My choice no doubt reflects my research instrument—myself. In research one normally exposes the research instrument, so I will say something about myself. However, describing oneself is fraught with difficulty. To address this I asked close colleagues how they saw me. In summarizing my characteristics in relationships with others in mainly educational settings, five adjectives emerged: confident, sociable, questioning, rational, and caring—though each with provisos.

My confidence can be seen as assertiveness (I am always willing to give a point of view), and can be interpreted as arrogance, but it also means that I can be shown to be mistaken or look a fool without it upsetting me. Linked with confidence is being sociable—I relate to most people well, though not so well when emotions are involved for then my *bonhomie* is used to cover my lack of confidence. My questioning attitude includes a habit of inquiry into alternatives—this has been interpreted as being argumentative, assertive, and rebellious, and as being tentative and *wanting it both ways*. My rationality has, quite justifiably I accept, been seen as unfeeling. Indeed, with adults in particular, I can find it difficult to be empathetic. One good friend used the phrase *emotional cripple* but I believe that was overstating the situation; another said *the typical man thing* and perhaps that is so. I am quite caring although this is often seen as rational rather than emotional behaviour.

My ways of thinking have changed significantly over the years. Until the late 60s I would have regarded myself as a positivist with left-wing political leanings. In the 70s I moved to a more pragmatist stance with more concern about social issues. In the 80s I took on the ideas of constructivism and a more relativist perspective, while my politics moved more towards a *green* position. In the 1990s the extremes of NZ's new-right politics led me to a complete lack of faith about politics and concern about the way our society is developing. At the same time my thinking was changing with the growth of my understanding about systems theory and enactivist learning and I was starting to appreciate a greater connectedness between everything.

As part of this change in the 1990s one aspect stands out. The questioning of the dichotomies that seem to stem from Descartes but have early Judaic and Christian roots. Damasio (1994) was one of the writers who contributed to this change. These dichotomies include the separation of self from others, mind from body, and personal from professional and social. I believe that we have extended these to include mathematics from other subjects, learning from teaching, schools from life, schooling from education, past from present, and work from play (apart from at conferences). Many of us, particularly males, also separate cognitive from non-cognitive knowing. This way of thinking with dichotomies contrasts with Asian thinking where contradictory elements are juxtaposed and seen as complementary, and I believe that we need to consider incorporating such thinking into our work.

Now, informed by my enactivist orientation, autobiographic research involves me in making the following assumptions that have arisen for me:

- 1 Individuals (including me) interpret their worlds idiosyncratically; such interpretations are subjective (not necessarily wrong, rather, alternative), and some are more *fitting* or appropriate.
- 2 There are non-traditional ways of *coming to know* including interpreting body language, using intuition, and being mindful/aware.
- 3 Research is not observing, interpreting, and reporting, it is dialogue and change.
- 4 Data is interpretation, because choice of data to collect and *reading* of data both assume to some extent some (often tacit) hypothesis/assumption.
- 5 In research one cannot separate knowledge, activity, and identity, (that is the research data and interpretations, the process of researching, and the researchers).
- 6 Assumptions about cause and effect are not relevant with complex systems; the best one can say is that some things are influential; and descriptive reports with brief-but-vivid accounts-of are useful to portray qualities rather than quantities.
- 7 In a research report one does not report *what is* or *what was* as reality is ever-changing. One reports one's interpretation of some aspects of a research journey. Varela (1987) spoke of this as *the path laid down while walking* and Maturana said *we create the world as we live in it*. A report is useful if it provides something that others can *resonate* with, then reinterpret, and grow.

Having set the scene by indicating my path, presenting ideas that underpin my thinking, and discussing my ideas about autobiographic research, I now move on to the second part of this study which covers the first 40 years of my life.



## PART B Learning about curriculum

### Chapter 4 Being educated

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#### 4.1 Looking ahead

My life's first two phases were my pre-school years (1940–45), and my years as a learner in educational institutions (1945–62), and these are the focus of this chapter.

In my story I use *incidents* in order to focus on events that influenced my thinking on educational and curriculum matters (though I would not have known the word curriculum at that stage). I have included background information to make my story more contextual and therefore more understandable. Some of these incidents occurred at home while I attended primary school or was on vacation from boarding school and these have been interwoven with school incidents.

For some time during the second phase of my life I taught swimming and gymnastics. Although these occurred while I was being educated I have reported on them separately as they reflect different ways in which I learnt to teach.

The first two phases of my life are summarized in figure 4a.

Table 4a: *Time-line for student days and first teaching experiences.*

1940	Born			PHASE 1
1941				
1942	At home			
1943	(informal learning)			
1944	Kindergarten (2 days/wk)			
<hr/>				
1945	PHASE 2			
1946				
1947	Lived at home and attended Pukekohe Primary School			
1948				
1949				
1950				
1951				
1952				
1953				
1954				
1955	Attended high school			
1956	Mt Albert Grammar School		Taught swimming	Taught
1957	[boarded at school]		in summer with home	gymnastics
1958			town swimming club	
1959	Full time university		Set up a swimming school and	
1960	student (mathematics degree)		taught swimming in hometown	
1961	[boarded, university hall/house*]		as summer vacation job	
1962	Attended teachers college			(* married)

## 4.2 Growing up at home

I was born in 1940 in Pukekohe—a small NZ rural town of under 2000 people. I lived at home and attended the local primary school, then, although there was a high school in Pukekohe, I went to Auckland city where I boarded at high school. Boarding schools served children from remote areas and the privileged class, and reflecting on my upbringing, I belonged to the second group. My father was a general practitioner, one of three doctors in the town, my mother had attended fine arts school after high school but was not in paid-employment. I had an older sister and brother, and a non-identical twin brother. At the time I believed that NZ was generally egalitarian and racially harmonious but as a child I was aware of some

class and racial discrimination, and that I belonged to the privileged class where I experienced a very comfortable and happy upper-middle class family life. At the start of my life there were four children under three and we had a nanny, we also had some home help, a boarder from Scotland lived with us, and my maternal grandmother and maiden aunts lived only 2 km away. We had a beach house 100 km away where we spent much of our summer holidays. In 1944 I had attended a private kindergarten (there were no state pre-school institutions in our town); my only real memories of that were walking to and from with my brothers.

### **4.3 Enjoying primary school**

In 1945 NZ's education system was modelled on Britain's but was developing some autonomy. The curriculum in the first five years focussed on spelling, reading, writing, arithmetic, social studies, nature studies, music, physical education and sport; this was extended to include gardening in years 6–8, and technical subjects in years 8 & 9—woodwork, metalwork, and technical drawing for boys, sewing and cooking for girls.

I have pleasant memories of primary school. I had not thought why one went to school, one just did. I was able and nearly always successful. I could not understand why my twin did not do well with spelling, and I realized that other students had problems with many topics. I was self-motivated and keen to learn everything, and this attitude stayed with me throughout primary school; with hindsight, perhaps because I was successful. From year 3 on we used government issued textbooks for arithmetic, but not for other subjects. We used *School*

*Journals* produced by the Department of Education for reading from years 3 onwards and our school library which was supplemented by a changing collection from the national school library service. Projects were used in class and I now know this was because the Director of Education had been influenced by Dewey's writings and had introduced, what was known derogatorily by many parents as, the *playway* in education.

### ***Mathematics***

Mathematics at primary school was arithmetic. The topics I remember were: number (including fractions, decimals and percentages) and simple operations, money (including decimalisation of £ s d), simple measurement and areas and volume formulae, and averages (i.e. arithmetic means). I have three vivid memories related to mathematics—number in the world, learning, and assessment.

#### ***Incident 4.1—Letter boxes***

*Walking home from school, age six.*

*I noticed that every second number was missing from consecutive letter boxes.*

*A day or two later I found them on the other side of the road.*

*I checked another street to find if it was the same.*

*I remember wondering why?*

*Then I saw a pattern that made sense if the next number was across the road.*

*Reflecting now—this was an early patterning experience; no teacher was involved. Is patterning a natural power of children? I think so.*

*No teacher was involved, yet I was learning, and I wonder whether curriculum adequately acknowledges what is learnt outside school.*

### ***Learning***

In our first two classes in particular, but also later, we learnt tables—not only for multiplication, but also for division, addition, and subtraction.



### *Incident 4.2—Chanting tables*

*Year 1, age five, chanting in a sing-song way, for example:*

$3 \times 1 =$	then	$3 \div 3 =$	also	$3 + 1 =$	and	$4 - 3 =$
$3 \times 2 =$		$6 \div 3 =$		$3 + 2 =$	and	$5 - 3 =$
$3 \times 3 =$		$9 \div 3 =$		$3 + 3 =$	and	$6 - 3 =$
and so on to						
$3 \times 12 =$		$36 \div 3 =$		$3 + 12 =$	and	$15 - 3 =$

*No questions why, this was just a fun way of learning, and up to  $12 \times 12$ .*

*The pattern between  $\times$  and  $\div$  and between  $+$  and  $-$  makes it easy.*

*Reflecting when at high school—the teacher's aim was automatic recall.*

*Reflecting years later—was this drill and practice, or what I later came to know as drill for understanding. Should teachers make links explicit, or encourage children to do so? I think they probably should do so, and this links with the curriculum phrase 'making connections'. And, chanting/singing, do we use children's love of this sort of patterning enough in school and in mathematics? Perhaps not.*

*Thinking of Mason's (2002b) notion that 'a lesson without an opportunity to generalise is not a mathematics lesson', these were mathematics lessons for me. The patterns were not made explicit, but I saw them. In addition to the inverse properties, I remember seeing going down the three-times table as adding three (a form of repeated addition).*

*The pair-wise use of tables was interesting. The teacher only made the link implicitly. I wonder if she thought it was obvious. It was for me, but would not have been for many.*

*This highlights an ongoing curriculum dilemma—whether a curriculum should specify (or even suggest) how a topic be taught.*

### *Assessment*

*We were assessed every day for spelling and mental arithmetic. This upset some but*

*I was in the top achieving group and it did not worry me. Other work was regularly*

*assessed, and each term we had reports based on class work and examinations.*

### *Incident 4.3—You don't deserve 100%*

*Year 7, age 12. I was given  $99\frac{1}{2}\%$  for a test*

*I asked why it would not be rounded up to 100% as other people's marks went up.*

*The teacher replied "You don't deserve 100%"*

*I thought "Unfair" though I also knew it was the top mark.*

*In hindsight I realize that I had often questioned the teacher's authority (see incident 4.10) and he was probably annoyed by my arrogance. However, I think that consistency and fairness should be part of the hidden and enacted curriculum.*

*I see encouragement at all levels is desirable, and assessment as influencing motivation positively for achieving students and negatively for others. This has implications for the assessed curriculum where the benefits of motivation need to be considered alongside accountability.*

### ***Other subjects—learning and research***

My best memory of learning at primary school was in year 8, not in mathematics but in social studies (although it involved scale drawings, graphs and statistics).

#### ***Incident 4.4—Canada***

*The teacher asked us to select any country of the world that interested us as a project topic, research the country, and write up our projects. I chose 'Canada'.*

*About two weeks later I handed in a 40-page exercise book full of work on the topic.*

*Most students did their projects on large sheets of paper but I had realized that this would not be enough space for me. I used schoolbooks, library books, and had access to resources at home. I felt confident choosing my topic and having no restraints on my work.*

*In hindsight, is there enough choice in the curriculum? Do we give students enough choice? I think not, though subjects other than mathematics do give more choice.*

*Do we set enough open-ended and time-extended activities in mathematics? Again, I think not, yet other subjects do. And do such open-ended activities suit less-able students? I think they do when many options are available within the activity. Would other students be as confident? I accept that my privileged upbringing helped, but I believe confidence is learnt.*

*In terms of curriculum, in particular textbooks and resource banks, there seems to be a need to build more extended tasks (although providing teachers with tasks is no guarantee of their use). Also from a curriculum perspective I am concerned that the reliance by schools on home resources advantages already privileged students, but on the other hand I would not want to see these students held back.*

This project was the largest I did before high school. It reflected Dewey's emphasis on natural inquiry, learners' interests, and projects. With this project I neither asked

for nor received help from my parents though I am sure they would have assisted me if I had asked. Recently in schools I have seen children's projects with a considerable parental input and this causes me concern, though I acknowledge that it is natural for parents to want their children to succeed, especially when the stakes are high.

I was an inquisitive child—I think most children naturally are. I had made a one-valve radio when 13 and wanted to know how it worked. This was not for school, though my findings were presented as a morning talk to my year 8 class.

*Incident 4.5—How a one-valve radio works*

*I asked my father and my teacher how a one-valve radio works. Neither knew, nor did they suggest where I might find out. I had already looked at books that said how to make a radio, but not what each part does and how it works so I asked the local radio repairman from whom I had bought the various parts. He was keen to help; so I spent hours with him having the process explained. When I asked for more detail he patiently gave me more. Finally I thought I understood and was satisfied that I could give a morning talk to my class.*

*At the time I was sure I knew how the radio worked, and I wondered if the class understood what I said, I thought possibly not.*

*In hindsight—was I being a precocious child showing off? Probably yes. Did I really understand? Only partially I am sure—indeed I would still have trouble explaining radio waves; but from a constructivist perspective, is our schema ever complete?*

*Do schools encourage community learning enough? I think not, yet much more is possible. Perhaps learning that occurs and opportunities that exist outside schools need more recognition in the curriculum.*

During my primary school years I was encouraged by my parents in numerous after-school activities including learning to play the piano, joining cubs then scouts, and playing sports (joining athletics, swimming, and gymnastics clubs). My favourite sport was swimming. My twin brother was a better freestyle swimmer than I was so I concentrated on breaststroke and backstroke so that I was not competing against him.

With this ability to swim, I went on to participate in many other water sports and my success and confidence in swimming and related sports had an influence on my later life. Another aspect of my interest in swimming is the focus of 4.7.

My father had been keen on gymnastics in his youth and encouraged my twin and I when we were 11 to join a newly formed children's gym club. It sounded like fun and we went off willingly. The instructor was an experienced teacher, we had fun, learnt numerous skills; and became keen gymnasts. My attitude to gymnastics differed from that of my twin—he always wanted to do things perfectly, and practised each skill, I was keen to learn new skills and have fun. Our instructor coped with our different attitudes and with those of other children, and my twin and I continued our involvement in gymnastics for some years.

My older brother and sister had learnt to play the piano and my twin and I agreed to learn when it was suggested.

#### *Incident 4.6—Learning piano*

*Our first piano teacher taught the basics and within a few months I could play some of the popular hits of the day, some well-known songs, and some simple classical music. Then she left town for a job playing piano on radio.*

*My parents found another teacher; she was more traditional—more exercises, no hit tunes, and practice with theory examinations. I continued for a further year or so, but my enthusiasm diminished, though I lasted a little longer than my twin who had seemed to me to learn to please our parents rather than for his own enjoyment.*

*Piano was fun with the first teacher, and I was playing music that I heard on the radio. The second teacher did not build on my interests and I had not developed an interest in her music.*

*In hindsight this demonstrated the importance of building on the interests and prior ideas of the learner. The first teacher had done so and I enjoyed lessons and practice, the second had not, and (unfortunately) I soon lost interest.*

At high school a fellow student taught me to play piano using guitar chords for the bass and the melody for the treble, then at university I briefly dabbled with the clarinet, and when 55 I purchased a keyboard so my interest in music has continued.

A regularly reinforced learning experience was about capitalism and the meaning of owning shares.

#### *Incident 4.7—Owning shares*

*Our family regularly drove from home through Auckland. Each time we drove past a particular office building dad pointed to three windows at one end of the building and said “Those three windows are mine”. After this happened a few times my brothers or I would anticipate him and point and say “Dad, there are your three windows.” After some time we asked him why they were his and he told us about owning shares.*

*At the time it seemed like just a fun activity in the car.*

*The lesson was understandable, it was structured at the level where we would enquire further, and it was an indoctrination into capitalism—part of dad’s natural ability as a teacher and his political leaning.*

His later lessons about capitalism involved gifting shares to us, encouraging us to save dividends, and ensuring we purchased more shares when new ones were issued, even though we were still at school. I think of this as *revision* of his earlier teaching.

#### **Religion**

In the 1940s and 1950s NZ was a Christian country; if you asked what religion someone was then you really meant what denomination. At school we had an hour each week when a minister from one denomination or another came and talked to the class. I went to Sunday school and church with my brothers and sister and enjoyed the singing and the stories.

#### ***Incident 4.8—Bible stories***

*At Sunday school we read and were told bible stories. Like stories in other books many seemed make-believe, especially the miracles. I could see reasons for the commandments—they seemed sensible.*

*I could not accept Christianity as an act of faith. No one in the family pushed. I kept asking 'but, if' type questions. I wondered whether bible stories were meant to be believed or if they were metaphors?*

*In hindsight, I seemed to accept reason rather than external authority and wonder, is this what society wants as an aim of curriculum?*

*Compliance or questioning? I prefer questioning, but accept that reason sometimes needs to be tempered by empathy and respect?*

*From a curriculum perspective the aims of education (compliance or transformation?) are important, but encouraging questions and discussion provides opportunities for deepening understanding.*

#### ***Relating to others***

*One particular memory of school stands out which made me think about who really knows and about me relating to and respecting others.*

#### ***Incident 4.9—Abbreviations***

*Age 11, year 7, an English lesson about abbreviations. The teacher asked about BA, BSc, and other abbreviations. He asked what MB ChB stood for and as dad was a doctor my hand went up. When asked I replied, Bachelor of Medicine and Bachelor of Surgery. The teacher said yes to the first but that the second was Bachelor of Chemistry. I countered saying that it was definitely surgery not chemistry, it was from the Latin word for surgery, and was in the dictionary. The teacher disagreed but did not check the dictionary. I knew I was correct.*

*My immediate thought was that some adults don't know things. I rejected my teacher's authority and accepted that of my father and the dictionary—but I learnt that 'authorities' are not always correct.*

*I heard a few weeks later from my mother that at golf my teacher had said that my open questioning of his authority was annoying, and he had checked later and I had been right, however he never said that to me.*

*On reflection I wondered why some teachers can't admit that they do not know or are not sure—within a spirit of enquiry (and an enquiry-based curriculum) that is what a teacher could do; and, why don't teachers encourage questioning such as mine.*

*Some years later as I gained more understanding of people's feelings I realized that my open-questioning of authority must have made me hard to get on with! I also came to understand that questioning was unacceptable in some cultural settings.*

At home during this time I learned about discussion and argument and its role in coming to know. My father always talked about things with us and when I had a definite opinion (which was fairly often) he would gently argue the opposing view. I was not aware of this as a *game* until the following incident occurred.

*Incident 4.10—Changing sides*

*Dad and I were discussing something—I cannot recall the topic. A family friend came into the room, heard what I was saying, and like dad, responded by suggesting the opposite. Dad, who had been taking the position opposite mine smiled, immediately changed sides, and argued with me.*

*Discussion or argumentation was obviously a ‘game’ we played, it was fun, it was a form of thinking aloud, and there were always at least two sides.*

*Presenting an opposing point of view has always helped me to see the other perspective, and think more clearly about my own. (I later was to use a similar approach in school—see section 5.5)*

*Do schools encourage and support argumentation enough? I think not. Thus, I was pleased in 2005 to hear two teachers (Vaseo & Hinton 2005) discuss the philosophy classes for young children at their school which indicated a possible way forward.*

Related to argumentation another minor incident made me stop and think. At my sister’s funeral in 2004 I met one of her classmates who had visited our home when I was about 13. This woman told me how she had entered our living room, heard my father and I discussing/arguing, and was so embarrassed that she left the room. She said she had been shocked and had never heard a child argue with a parent like that. I did not recall the incident but thought about such discussion as part of Dad and my regular interactions. I wondered, was such overt argumentation or discussion not normal in family life, and was it disrespectful? I knew other people argued about practical things and wondered, do children not debate ideas? I also knew that in some cultures children are expected to observe silently, but had always assumed that did not include our Anglo-Saxon culture? Perhaps it had appeared disrespectful.

However, I think that schools need to do more to stimulate debate (including group debate to be inclusive of some cultures). Without debate it seems schooling encourages compliance rather than questioning and teachers miss teaching/learning opportunities. This raises two issues, whether it is culturally appropriate to teach questioning of authorities, and how might discussion be encouraged in a culturally appropriate manner—these issues have arisen later in my life with teachers in the Pacific, with Maori, with ethnomathematics, in Pakistan and with Asian and Polynesian students in universities.

#### **4.4 Attending high school**

At age 13 it was time for high school. My parents assumed we would benefit from attending a school in the city and from 1954 to 1958 I boarded at Mount Albert Grammar School in Auckland. This was a state school for about 800 boys with a hostel for boarders. My memories of boarding at high school are mixed, generally pleasant, but I resolved not to send my children to boarding school. The first decision made at high school was about course options.

##### ***Course options***

##### ***Incident 4.11—Choosing options***

*My twin and I opted for different courses so we would be in different classes; I chose the two-language option and he opted for the one-language one. Neither our parents nor we were aware of the consequences of our choice.*

*I was lucky, the two-language stream was regarded as the 'top' academic stream, and I managed to get into the top of the three classes in the stream.*

*High school course options and subject choice differed from primary school and I wondered why some students opt for fewer subjects?*

*I slowly realized that the 'top' class meant better teachers, higher expectations, a different curriculum, and understanding rather than rote-learning.*



*Students from city schools had already studied French and Latin and I was at a disadvantage (made worse by being ill and absent for 6 weeks of term 1).*

*Why is the curriculum different in city and rural schools? But why should city students be held back? How can such disadvantages be overcome?*

*Streaming on the basis of ability and course options seems based on the 'myth' that the purpose of the school is sorting, or 'survival of the fittest' (Beeby 1986, p xxii), but this is largely a self-fulfilling prophecy when 'top' classes are advantaged. It seemed unfair, an aspect of the 'hidden curriculum' in some schools.*

I slowly came to realize how much I had been advantaged by choosing the two-language option and how my twin had been disadvantaged by his choice and even at school I wondered about the fairness of this. I was reasonably successful academically at high school but that is only one measure of success; my twin had numerous sports successes, cadet promotion, was a house and school prefect a year before I was and became 'head' prefect of the school.

At high school the programme (curriculum) began to become problematic for me.

Unspoken questions bothered me, these included:

- Should there be more or less subject-option choice?
- Should parents or students make course decisions?
- Are Latin and foreign languages only suitable for academic students?
- Are non-academic students not interested in physics?
- Why can't I as an academic student do technical drawing?
- Can all students not cope with 'full' mathematics?
- Were five subjects enough at years 12 and 13?
- How can people choose a 'stream' at age 13 when they (like me) keep changing their minds about jobs?

## ***Mathematics***

High school mathematics was not a single subject. It started as three—geometry on Monday and Thursday, algebra on Tuesday and Friday, and arithmetic on Wednesday. Trigonometry replaced arithmetic from year 11, and in years 12 and 13 coordinate geometry replaced traditional geometry and calculus was introduced. Also, in years 12 and 13 additional mathematics was available as a subject. We had separate textbooks (from England, authors included Durell, Fawdry, Hall, Loney, Robson, and Stevens) and separate exercise books for each *separate* subject and each day had to bring the appropriate textbook and exercise book to class.

Geometry was introduced in year 9 (age 13) with axioms being defined as *self-evident truths*. We were assured that while axioms *seemed to be true*, alternative axioms were always possible and these would lead to different mathematics. After talking about the axioms the routine started, each period began with a test on the previous theorem (or construction), a new one was taught and we completed riders (examples) based on it, then finished these for homework. The freedom to choose axioms was reinforced for me by the notion of freedom to choose alternative proofs (see incident 4.11); and the first seeds of the idea that the subject was relative and was a human invention rather than a discovery were sown. Later in life I realized that the way Euclidean geometry had been organized by Euclid and was still taught in the mid-fifties needed to be questioned because most students found it very difficult; and this notion fits with both the mathematical argument of Hersh (1997) that the axioms do not come first, since they are merely part of the formalisation that occurs when a piece of mathematics is systematised; and with the van Hiele model about learning

(Crowley 1987) where logic is not the starting point. However, at the time I enjoyed the logic of theorems, the logical system that unfolded, and success. Being busy and successful, I did not at that stage question the nature of high school mathematics.

#### *Incident 4.12—Alternative proof*

*Year-nine geometry, theorem: "If two sides of a triangle are equal, then the angles opposite these sides are equal." The headings we were expected to use were: Theorem, Diagram, Given, Required, Construction, Proof, Conclusion.*

*We were taught to construct an angle bisector from the angle opposite the third side, and prove the two triangles were congruent (using two sides and the included angle).*

*We knew not to rote-learn theorems for tests as differently positioned figures would be given and lettering changed (often with the same letters used in different places).*

*A friend and I thought a shorter proof with no construction was possible. We thought that we could prove that the triangle was congruent to itself reflected (using SSS instead of SAS), and I used this in the test though my friend did not.*

*The 'correct' work was handed back—mine was apparently incorrect. Then the ones that had earned a detention—still not mine, why? The teacher then said "And then there's Begg!" he paused, I felt very apprehensive. Finally he said, "At least one person in the class is thinking," and showed the class my proof.*

*I had been feeling concerned, then very apprehensive, but finally felt great.*

*A few years later when teaching I reflected and thought, 'would I ever do that to a student?' I thought not, the potential embarrassment was more than many students could take. Yet at the same time I had felt proud.*

*Would other students not enjoy that?*

*Thirty years later as I learnt more about indigenous cultures I realized that this would be culturally inappropriate with Maori and Pacific Island students. They do not like been singled out. They prefer group not individual praise, and would have probably felt publicly 'shamed'.*

#### ***Expectations and motivation***

On my first day of high school classes we went to each subject classroom and with one exception the procedure was the same. We lined up outside the classroom alphabetically by surname, and then were directed in one at a time to sit in an assigned place. My name meant that I sat in the front row on each teacher's right.

The teachers then proceeded with administrative matters. The exception was science.

#### *Incident 4.13—First day of high school science*

*We lined up in the corridor outside the laboratory. The teacher arrived, opened the door, and directed us in small groups of four to the ten laboratory stations. He then had us take out a Bunsen burner from our equipment cupboard, light it, get some sulphur in our test-tube, heat it, observe, and investigate the states of sulphur. As we were doing this he walked around the room and checked our names and lab stations.*

*We were hooked on science from day 1. It was our first day in a laboratory and we were doing the things we thought science was about. Other administrative tasks were completed over the next few days, but they were always secondary to the exciting learning of science.*

*Priorities are important, we felt we were really doing science! I'm sure all subjects could start this way and keep administration in perspective, but as a teacher I know that administrative tasks have to be done.*

In my first year our mathematics teacher made us aware of the high expectations the school had of us. He assured us in the first week of school that we would all be sitting the scholarship examination in five-years time.

#### *Incident 4.14—Confidence building*

*At the end of my year 9 the year 11 students sat a 3-hour external examination for mathematics (School Certificate, Mathematics A: Arithmetic and Algebra). That afternoon our teacher had a copy of the paper, and put more than half of it on the board. We had 45 minutes to do this work. That night he marked it. Next day we found we all had high marks, and many of us had 100%.*

*At this stage he assured that we would all pass in two years time, that most of us could have passed the whole paper then, and he reminded us to set our sights on scholarship (year 13) rather than on school certificate (year 11).*

*We knew our teacher was a tough marker, so 100% made most of us feel confident about our mathematical ability.*

*In hindsight he had obviously chosen the sections we could do, but it was a very positive experience for the class. This incident links with what Firsov (1996) said about success as an important motivating influence.*

#### *Assessment—mathematics and other subjects*

My mathematics teacher in year 9 was the head of the mathematics department. He believed that mathematics was the most important school subject. While teaching at the school (eight years later) he told me that he always marked school examinations

so that the top marks were spread over a very broad mark range; and as there was no inter-subject scaling this meant that mathematics (pure and applied) marks had an undue influence and virtually determined student ranking. He also did this with school entry examinations (an English test, a mathematics test, and an IQ test); this meant that the top academic year 9 class included the potentially best mathematics students. This was fine if one was good at mathematics, but if one was average one might only attain 10% and a number of his ex-students from the top class later recounted how they had been turned off mathematics. I was not as sensitive, I was content if I received a good mark, or was in the top 1/4 of the class.

I learnt about assessment in other subjects too. The year 10 Latin exam had 5 or 6 main parts, the first worth 20% was a translation from Latin to English. Half a mark was deleted for each mistake. I made 47 errors. My mark was  $\frac{3.5}{20}$  and this was added to the marks for other questions. I had thought the worst one could do was to score zero,  $\frac{3.5}{20}$  seemed punitive. This contrasted with the General Science exam where one question asked us to list the properties of oxygen. The question was worth 10 marks, I listed 24 properties assuming each was worth half a mark, and was given  $\frac{12}{10}$  for this question. The bonus marks seemed great. Some years later the science teacher told me that he had wanted everyone to be successful, and his marking was designed to ensure that the bottom person in the A class got at least 80%.

Comparing assessment policies, in science my confidence was extended, in language I learnt to dislike languages, and the mathematics policy did not worry me but did upset many students.

### ***Learning mathematics***

We never took notes in mathematics, we were expected to learn from doing many examples. I recall in year 13 taking 26 filled exercise books to school for the inspectors, these being my work in pure and additional mathematics.

We marked our work, a tick if correct and a cross for a wrong answer or a single line through an attempt to show that one method had been tried and found unsuccessful before making another attempt. Graphs were sketched rather than plotted; figures represented, as far as possible, *general* shapes; and we drew diagrams whenever appropriate. We were expected to be legible, organised (equal signs under equal signs), use correct symbols ( $=$ ,  $\neq$ ,  $\therefore$ , etc), and give reasons, in particular for geometric statements that we made. I believe that this approach supported my mathematical thinking and developed my understanding of mathematics as it was intended to with all of us in the top stream, though I accept that others may well have not done so. I saw evidence of rote learning by some students in other mathematics classes but did not see this as helping their understanding.

### ***Other subjects***

Four incidents occurred in English classes with the head of English who was our teacher for three years as well as being the senior master at the hostel where I lived.

#### ***Incident 4.15—Quotations***

*Age 15, year 11. We were revising quotations (source and author) for the external examination. The teacher read "Blessed are the meek ..." My hand was the only one in the class to go up. "Well Begg, you bloody heathen, what do you think?" "Bible, sir, St Matthew, part of the Beatitudes, Chapter 5 verses 4 to 12." "Yes, you're right, I am impressed, I didn't expect that from you!"*

*It seemed good-hearted repartee, we knew each other well (although day boys may have been less confident with him than boarders were).*

*Was the 'bloody heathen' sarcastic, or light-hearted banter? I thought the latter, but later wondered what possible effect such a remark might have on a student? It had not worried me, but within a few years it was not acceptable language.*

#### *Incident 4.16—Bleak House*

*Age 16, year 12. Whole class studying Dicken's Bleak House; second day on topic: "Get out your copies of Bleak House."*

*"Oohhhh no' (an audible sigh all around the room).*

*"Don't you boys like Bleak House?"*

*In chorus "No!"*

*"Well put the books back in your schoolbags"*

*He told us he would borrow a class set of readers, but asked us to keep our purchased copies of Bleak House as he was sure that one day we would enjoy it.*

*Next week he had a class set of Williard Motley's "Knock on any door" I still remember the first line, 'Live fast, die young, and have a good looking corpse!'*

*At the time my reaction was relief. I hadn't liked Bleak House.*

*However, my reaction to the new book was, "But is this literature?"*

*In hindsight this was another example where the teacher respected our immaturity, built on our interests and worked within our 'zone of proximal development'.*

*He was correct—I kept my copy of 'Bleak House' and about 30 years later read and enjoyed it.*

#### *Incident 4.17—An author of your choice*

*Age 17, year 13. "Choose an author, do some research, find out about his/her life, times, works, ...". The expectation was a 30 to 40-page essay. I chose George Orwell, reread "Animal Farm" and read "1984", and for the first time purchased commentaries to read as the school library lacked material on modern literature.*

*It was challenging. Our teacher's expectations were high. I appreciated having a choice. On completion I felt I had achieved something worthwhile.*

*Fifteen years later, half way through my teaching career, I remembered that we had been preparing for scholarship, yet still had choice. That seemed unusual as curriculum statements had become more detailed, but it had been appreciated. And then I wondered, why did I not provide choice like that in mathematics, and where might I start?*

#### *Incident 4.18—T S Eliot's 'The Waste Land'*

*Age 17, Year 13. Modern poetry.*

*The teacher said 'poetry', my heart sank, I thought 'oh no!' We were given Eliot's "The Waste Land", and shared reading it in class. It was different.*

*Finding that Eliot provided pages of notes to help readers understand his work was something entirely new. I read them. The notes ranged from English literature to Greek, Latin, French and from Christianity to Buddhism and the Upanishads.*

*For the first time I began to appreciate the multi-layered meanings and see that understanding was virtually never complete. I also felt humbled and thought "Wow, is this what education leads to!"*

*At high school I had enjoyed mathematics and science, but this was a whole new dimension, my view of poetry changed.*

I enjoyed mathematics, but science, in particular chemistry, was my favourite high school subject. This preference had begun in my first week at high school (incident 4.13) and developed further in year 13 chemistry when I was again taught by my first science teacher and found that choices and explorations were part of learning.

#### *Incident 4.19—Exploring chemistry*

*A 1.5-hour period each week was for exploratory laboratory work rather than teaching. We were encouraged to do experiments that we wanted to do. We obtained permission, set up our equipment, did each experiment, and wrote it up in our lab books. We knew that the student with the best lab book would get the chemistry prize. The experiments could be related to class work, or our own interests, and occasionally, to stimulate us further, a bottle labelled X or Y was made available for qualitative or quantitative analysis.*

*I enjoyed this challenge, I read round the subject, found interesting things to do in a way that I would not have otherwise done, and won the chemistry prize.*

*When I finally left school resolving to be a teacher I assumed that I would teach science and chemistry.*

*Why are such open-ended activities not available in all chemistry classes and in other subjects including mathematics? I am sure that there are enough stimulating mathematics books available that students could learn a lot in this way—though as a teacher I admit to only rarely offering such opportunities.*

This open-ended opportunity had encouraged keen students including me to read around the subject, to look for alternative experiments to do, and to take initiative. Less motivated students tended to simply do experiments that had been outlined in class. This freedom to learn delighted me.



At high school we had physical education classes and were expected to play sport for the school in competitions against other schools. In summer the main choices were cricket, tennis, or softball, although school athletics and swimming sports were held to select teams to compete in inter-school competitions. In winter the expectation was virtually replaced by compulsion, and commitment to a sports team meant attending practice two days a week and playing for the school every Saturday. Playing sport for a club rather than the school was not an adequate excuse. Sports such as gymnastics, boxing, table tennis, and life-saving were assumed to be extras and not replace team sports. I preferred individual sport rather than team games and the summer expectation, the winter compulsion and the competitive element annoyed me although this was the typical extra-curriculum emphasis of the 1950s.

Although boarding at school I was permitted each Sunday morning to train at the city swimming pool, and my twin and I were allowed to extend our interest in gymnastics beyond what the school offered by joining a gym club which met one night each week in the city. This involvement in gymnastics led to my first teaching. When I was 15 our gym coach asked us to assist him with an after-school gym club in a local primary school. Most of our work was safety monitoring, ensuring a student did not fall after a vault or whatever, but we also assisted in some individual teaching. This was my first 'teaching' experience and I found I enjoyed working with younger people, helping them, and sharing the joy of their successes.

While I was in year 13 my older sister was studying pharmacy. I helped her prepare for her exams. She had to learn a list of things from the *British Pharmacopoeia* that

she could easily look up when she needed to, and that seemed odd to me. Much of the material I could make sense of on the basis of year 13 school chemistry. She rote learnt it which I had difficulty comprehending. Throughout this time, and later when she was qualified, she had many arguments/discussions with my father and these made me aware of the tentativeness of so-called scientific knowledge, at least in the context of medicine.

Another subject that interested me was religion. Because of my interest in radios and stamp collecting I became a regular browser in a particular shop and spent many hours talking with the proprietor. He was fascinating, he belonged to the theosophist society, went to a liberal catholic church and was interested in yoga, meditation, Buddhism, and eastern religions; I read books that he lent me. These books and discussions were an eye-opener for me, I was sceptical but interested. I found myself asking the *big questions*, my doubts about the Christian religion were reinforced, and I began to think about spirituality differently—as personal development rather than religion-based.

### ***Relating to others***

While at school I enjoyed dancing class and church socials, or more honestly, meeting and interacting with girls. I was away from home and had been somewhat homesick but had developed more independence though also emotional remoteness from family. I related well with most of my teachers. Our school was age-level conscious and interactions between year groups did not often occur at school (although it was different in the hostel). In my last year at school I was a school

prefect and house prefect, and this, along with my awareness of the lack of age-level communication led me to question the hierarchical nature of high school.

### ***Some parting thoughts***

At this time a number of issues had emerged that influenced my thinking. I appreciated informal learning and at-home learning (incidents 4.1 & 4.7). I thought that mathematics was learnt through doing examples. I knew that drill with understanding (incident 4.2) had a place, and that questioning and discussion were important (incidents 4.9, 4.10, & 4.12). I valued project work and choice (incidents 4.4, 4.5, 4.16, 4.17 & 4.19). I was aware of the influence of assessment on motivation (incidents 4.3 & 4.14). And I slowly began to value relationship skills (incidents 4.9 & 4.15) and realized how they might influence learning,

I was aware that school subjects were academic or vocational with the main choice made at year 9 and further choices at years 11 and 12. Looking back I realize that this increased emphasis on vocational courses was a result of the Thomas Report (1943) and occurred at a time when the school leaving age had been raised to make some years of high school education compulsory for all. This was evident within mathematics, where vocational students had studied 'core' mathematics rather than 'full' mathematics, and I later found that the emphasis on 'core' mathematics was even more pronounced in girls schools.

My view of education had become *the teacher teaches, the pupil learns*. I assumed that practice helped, and was implicitly aware that understanding was the goal of

learning. I found that when I understood things I could work them out so I did not remember details—though I was aware that this was not how my siblings learnt things. I saw mathematics as a human construction that helped people explain some things, but other subjects were different. I appreciated the dilemma of waves and particles when discussing light in physics; and in chemistry, although we had learnt an orbital model for molecules, we had been told that a probability density function was a better model, and these two dilemmas helped me understand the nature and tentativeness of theory. In addition I was aware that I did not appreciate the allusions and sensitivities in literature.

My career aspirations had moved from running a grocery business (age 8—my first job was riding a grocery delivery bike in the holidays); to being a minister (age 10—a family friend quoted me as saying, one only had to work one day a week, the rest of the time one chatted up old ladies); then joining the navy (age 14—I was a school sea cadet). At 16 I tended towards engineering and accountancy, both being professional jobs that my father approved of, but part way through the next year I decided that teaching would be rewarding and that I wanted to work with young people. My father thought this was a backward step, though he was pleased that I went to university (see 4.5), and even more proud when a few years later I was not only a teacher (Ch 5), but also a textbook writer (Ch 6).

## **4.5 Experiencing university**

After high school I started at the University of Auckland. After three years of full-time study I continued there as a part-time student during my year at teachers college and for a further seven years while teaching full-time.

### ***Relating to others***

University was different from school. Only one year-one lecturer got to know us, he learnt our names, greeted us outside class, used our names when asking questions in lectures, and came to tutorials (other lecturers used graduate students for tutorials). Students seemed to be work by themselves and made little effort to get to know others. I was fortunate in being in a university hostel where there was a sense of community. I came to see interactions with other students, tutors and lecturers as important because the discussions about subjects seemed more beneficial to me than lectures—no doubt this was partly due to me not properly preparing for lectures nor following them up with further study. With hindsight I see both discussion and learning to learn strategies as important, and both were neglected.

### ***Teaching and learning***

Lecture notes based on material in our textbooks were dictated; we did not have time to think as we quickly copied things down. Some examples were set, and tutorials were available for help. I found my first year easy, as did others who had prepared for scholarship the previous year since few new topics were introduced. It seemed different for students from small schools; while they were not as well prepared in terms of the material being taught, they seemed to have learnt to work independently.

There were students who dropped out because we lacked support systems, it was “survival of the fittest” with a vengeance. Year two was when disaster struck for me. I finally realized that I had been *spoon-fed* at school, and did not know how to learn. I had begun my degree intending to major in chemistry but changed to mathematics where I could work things out rather than rely on remembering and recalling facts. However, working things out was difficult, mathematics was presented logically, in lectures I could understand the logic from line to line, even pick up errors that the lecturers made, but I often lacked an overview of what we were doing.

### ***Mathematics***

Much of second and third year pure mathematics seemed more concerned with proof than problem solving and examinations emphasised reproduction of proofs, but my view may have been influenced by my doing insufficient problems. I was excited when Boolean algebra was introduced as I did begin to see the *relative* aspects of algebra, with laws that were different from those in traditional algebra.

In my third year I repeated a statistical mathematics course that I had failed the previous year. The first time I had taken the course the lecturer was a mathematician, the second time the lecturer was an actuary. The main difference was that concepts were taught in meaningful contexts rather than as applications of advanced algebra. Doing this subject I gained some appreciation of how contexts provided a scaffolding for learning, and how the ability to move between a general result and specialised applications is part of the subject and how applications are important for complete understanding—an idea which was later reinforced when I read Gadamer (1988).

## *Assessment*

In mathematics we had term tests and end-of-year tests. In science laboratory books marks also counted towards 'terms'. In arts subjects there were more essays. At the hostel the assessment that interested me was the architects' studio assessment.

### *Incident 4.20—Architecture studio projects*

*For about five days before 'studio' projects were due it seemed all the architects worked non-stop at the hostel producing plans, models and so on for their assignments. The projects were varied, not even all for the same site. Although they were busy they all seemed willing to talk to me about them while they were working.*

*I marvelled at the imagination shown by students, and by the way they worked virtually night and day for five days. I had not thought about assessment in such a subject and was surprised at the variety of different projects.*

*The willingness to discuss may have meant that communication was helping them firm up their arguments. I had not seen such open-ended projects before (and next saw them when school art work at year 11 changed to internal assessment and the portfolios of work submitted had a similar broad range of work).*

*I wondered whether mathematics could use such an approach for assessment. I think they could. When year 13 statistics had a project component these thoughts were confirmed, but then I wondered, why not at all levels?*

Another incident arose from my final year of full-time study and caused me to reflect on examination preparation.

### *Incident 4.21—Swotting for exams?*

*My wife was a little irritated when I failed subjects and repeated them the next year. She asked, "Why don't you swot for the final examinations?"*

*I replied, "Remembering for an examination is no use, I want to know the subject" She was not convinced by my argument.*

*I did believe that I was studying to find out, not merely to pass an examination.*

*I did not realize how much understanding develops over time, and that any swotting or revisiting a topic in fact is likely to contribute to the development of understanding.*

*I have never made such an argument explicit for my students, and they are more concerned about passing than understanding.*

### ***Other learning***

At university I was elected to the students' association executive and attended fortnightly executive meetings and numerous sub-committee meetings. During this time I learnt, in a very practical way about incorporated societies, administrative matters, the range of student activities, a society's constitution and standing orders, meeting procedure and chairmanship. This experientially-based learning proved to be most useful in later work on committees and with school meetings in my last teaching position. It also reinforced for me the value of practical experience in learning.

### ***Part-time study***

My first degree was in mathematics, and was completed part time while I attended teachers college. I felt it was adequate for teaching, but felt that I had reached my mathematical limit, so instead of continuing with a masters degree I decided to broaden out with a degree in a different subject. As I was intending to teach, education seemed an obvious focus for a second degree. I enjoyed my first-year education course—a general introduction to the subject; but in the second year there were some frustrations. The history of education paper had been interesting, the lecturer had listed the twenty questions that would be in the final examination, and told us to select four and prepare for them. This seemed reasonable, we were all in the same position, and we knew that he expected four high standard essays in the examination. I chose four, prepared for them and then the examination day arrived.



#### *Incident 4.22—Examination frustration*

*I opened the examination paper, the twenty questions were all in the paper. However the questions were organized in fours— either/or/or/or, and the first four were about Greek education and the second four about Roman education. I had prepared three Greek and one Roman question. I did one of each and chose two questions that I was not prepared for. I failed with 45%. I spoke with the lecturer, he told me that my first two questions were fine, but the last two were not. I explained why and he apologised for not being clearer in telling us to choose widely.*

*I was irritated with myself for trying to take the easy option, and with the lecturer for not being clearer. I did not like essays anyway (see incident 4.23) so decided to change from education to commerce.*

*I reflected on allowing students to prepare for an examination and giving choice. This seemed sensible in terms of students demonstrating what they know in the context of what is relevant for them, and it aligned assessment more closely with learning. I met resistance to this in schools but was able to put these ideas into practice in universities.*

My change to commerce was partly due to my frustration with examinations and essays in education, and partly because commerce offered a source of applications for mathematics. A third reason was that if I moved into educational administration it would be useful, and the fourth was my interest in business. One factor that reinforced the notion that I had made a sensible decision was related to language.

#### *Incident 4.23—Language registers*

*The markers comment on one of my education essay said, “You have all the important facts, but need to pad it out somewhat”.*

*The following year my first commercial law assignment was returned with the mark and comment, “14/17, 17 facts requires 17 sentences, not 17 paragraphs!”*

*I knew my writing skills were not good, neither mathematics nor science had provided opportunities for practice; the words ‘pad it out’ had grated with my notions of parsimonious elegance, while the comment on the law assignment fitted this notion. Providing ‘padding’ seemed to me to be simply stating obvious implications (although, in hindsight, there would have also been implications that were not obvious to me at the time).*

*Thinking about these two comments together was the start of my thinking about ‘appropriate language registers’.*

*What is the appropriate register in language? Does minimal elegance really suit the way students think? Or, do the van Hiele’s ideas (Crowley 1987) imply the need for a more discursive style? I think I was tending to an extreme while balance may be more apt.*

As I began economics I found it interesting to compare the role of mathematics and how it was introduced in economics and in physics. First-year physics was mathematical, all aspects of the subject were summarized using formulae, one did not merely find what sort of effect might occur, but it seemed more important to find the correct numerical value for it. However, in second-year physics there was little mathematics at all, it was concerned with the concepts rather than measurement. On the other hand, first-year economics was concerned about concepts with only occasional use of graphs, while the second-year economics course covered the same material but used mathematics—algebra, calculus and some statistics. (In fact, with a mathematics degree I was allowed to skip first-year economics; it was assumed that my conceptual understanding would emerge with the mathematics.) This experience with physics and economics caused me to wonder about the role of mathematics in other subjects. I knew that mathematics had not been the stumbling block for me with these subjects, but it was for some others. I gradually came to see the need for an iterative process, a continual moving back and forth between concepts, mathematical representations, and discursive teaching so that a broader range of students can be well catered for.

Economics reinforced my capitalist upbringing, and extended the contexts that I had met in mechanics (and physics) and used in class from the 2Ms (machines, military) to 3Ms (money being the new one). These turned out to be useful when I was teaching in single-sex boys schools, but not as valuable in co-educational classes.

## 4.6 Preparing professionally

In 1962 I spent a year at Auckland Secondary Teachers College preparing to teach high school mathematics. The mathematics education lecturer introduced *new mathematics* for schools, but then spent many hours apologising for it. He was coming to terms with it himself, and wanted to do all the old maths with the new instead of considering possible changes in emphasis. For example, with transformation geometry he wanted to prove all the old Euclidean theorems rather than to think of transformations as functions on the plane and to focus on invariance. As recent graduates we were aware of some aspects of modern mathematics but we had not considered whether these topics should be taught at school level.

Teacher education classes for mathematics and general education focussed on the practicalities of teaching rather than on theory—lesson planning, teaching strategies, and behaviour management strategies were deemed useful. Our planning fitted with behaviourism with an emphasis on analyzing the subject matter and focussing on specific objectives. Some evidence of ideas from Dewey lingered, in particular practical work and extended projects. Our experiences in schools provided opportunities to trial what we planned. The direct instruction that prevailed and that we had experienced five years earlier was not very different from what we were doing under behaviourism and our teaching was generally acceptable. When under pressure I reverted to how I had been taught, and coming from a school with an emphasis on ‘doing’ academic mathematics, this was not always successful.

During my year at teachers college trainees spent some time in schools. At that time it was sometimes difficult for schools to get teacher relief when permanent staff were ill and as trainees we were sometimes given full responsibility for classes.

#### *Incident 4.24—Classroom management*

*As a trainee I accepted a position where the teacher was ill and I had full responsibility for a mathematics class for a month. The class seemed to be going reasonably well, although one lad was somewhat disruptive. I decided to send him outside for a minute or two while I set the class working, then talk to him. Before I had finished with the class I heard "thwack, thwack", the deputy principal then opened the door and ushered him back into the room. (At the time, 1962, caning of boys was 'normal' in many high schools.)*

*I was somewhat shattered, the student had not done anything seriously wrong, I wanted to apologise to the student, and thought to myself that I must not send anyone outside again. At the end of the period I apologised to the student who smiled and said, "It was not your fault."*

*I imagine the deputy principal was trying to help. I wondered what he would have done if I had sent a girl outside. And I thought about how I might better manage the class.*

*I was more concerned about management than teaching; which is common with prospective teachers. As I now reflect I think if there is good teaching then management issues are less likely to arise.*

I had grown a beard while at University, and beards were reasonably uncommon in NZ in 1962. The principal of the teachers college was concerned that those of us with beards might be unacceptable in schools, many of which reflected the conservative society of the time. I did not believe that beards or clothes made a difference (apart from possibly making me appear a little older) and I did not have any negative experiences in schools because of my beard apart from one incident when applying for a job when the principal would not consider me. Perhaps growing a beard was my way of rebelling as a student, but the conservatism of this principal did remind me that many schools try to reflect the status quo and not question and transform society/

An important educational experience for me was the mathematics/science group's end-of-year week-long retreat.

*Incident 4.25—Retreat*

*The year at teachers college finished with a retreat at the beach. The purpose of this was largely social, perhaps to ensure that we knew each other so that we could support each other in our first year of teaching. We claimed it was to study 'wave motion'—so some took surfboards. At the retreat we spent time each day reflecting on and discussing our experiences during the year and making recommendations that we thought would improve teacher preparation in the future.*

*I chaired most of the proceedings and the two lecturers with us observed.*

*At the end of the retreat we wrote up our report and recommendations and gave them to our lecturers as well as to other college staff.*

*We had youthful arrogance but were realistic, we did not assume that our report would have much influence—we had voiced our concerns.*

*Twenty years later at a reunion held when our mathematics lecturer was retiring, he showed us his copy of our original list of recommendations with all but one recommendation ticked off.*

*These changes may have occurred anyway, but we were impressed that our lecturer had taken our concerns seriously.*

Teacher education did not stop at teachers college. There was no ongoing support from college, or much support within school departments at that time, but many of us joined the local mathematics association, and attended week-long 'teacher refresher courses' that provided in-service education. These refresher courses were held during vacations, they were fully funded by government, and in mathematics they supported the 'new math' curriculum which was being introduced over about ten years with schools opting for modern rather than traditional mathematics as they felt ready to change. My most important introduction to new maths was a series of adult education night classes that the professor of mathematics gave after I had left teachers college—these classes were unlike typical university courses and more like a course on the popularization of new mathematics.

## **4.7 Teaching swimming**

As a school student I had taught gymnastics, during summer vacations I had assisted the local swimming club with swimming classes, and I knew I was going to be a teacher. Traditionally university students sought holiday employment and I was no exception. I organized and ran my own swim school five days each week for three summers (1959–61) and spent the weekends as a volunteer in the surf life-saving club. I had no qualifications to teach children to swim, but after learning to swim I had been trained by two coaches, had helped with classes with the swimming club and felt confident that I had the necessary skills. I read two books about teaching swimming, and was ready to start.

One of my aunts did not think that I had the requisite patience to be a teacher. About a month after I had started teaching swimming she came into the pool, sat some distance away, and watched. That evening when I went home my mother told me that my aunt had been very surprised at the patience I demonstrated with my pupils. I knew I was not always patient within my family, but younger children seemed different and I had noticed when assisting the local swimming club and while teaching gymnastics, that pushing learners too fast sometimes scared them off. However, patience was only one thing, as I reflected on teaching swimming I wondered, how did I know how to teach a child to swim.

### ***Incident 4.26—Reflecting on learning to teach swimming***

***As each child came to swimming lessons I 'knew' I could teach them.***

***I did not 'think' much about it, my teaching was based on my experiential learning. Not thinking about it seemed to enable me to be more empathetic to learners. I could sense reluctance or fear and move to a 'safer' activity.***

*When we learn in a 'rational' way, do we at the same time unlearn our intuitive and bodily learning? I think we probably do, certainly as I 'thought' more and more about teaching in my later life I seemed to have expectations of but lose contact with the learner.*

*Do we need more emphasis on valuing intuitive knowledge and feelings in learning situations? I think we do.*

Virtually every student who came learnt to swim 10 yards across the pool after 10 lessons. Some made more progress, while some who began very fearfully needed a few more lessons. My most successful student was the subject of the next incident.

#### *Incident 4.27—Faulty identification*

*In my second year of teaching a 9-year-old girl arrived for lessons from an outlying farming district. While she waited for her lesson I noticed her older brother and sister dive into the pool and, with lovely styles, swim a few lengths. I asked the young girl could she swim and she assured me that she could not. She got into the water confidently and instead of the usual 'duck down with your head under the water and blow some bubbles', or 'take this flutter board and see if you can hold it and kick', I said 'see if you can swim across the pool as your sister does.' She immediately swam right across the pool in a relaxed style somewhat similar to her sister's style although she was not breathing properly. After one further lesson her breathing was fine, and after ten lessons she was able to swim the length of the pool (25 yards) using each of over-arm, breaststroke, and backstroke, as well as confidently dive into the pool from the side and from the low springboard.*

*A natural perhaps. She believed in herself, I got the feeling that she might succeed that way, and she did. I was somewhat amazed at how fast she learnt so much, and so was her mother.*

*I began to wonder if I expect too little of learners. And I wondered why she said she could not swim when she didn't know if she could or not.*

*The following year the same girl returned for some training sessions. On day one I had forgotten to bring my records from the previous years to the pool. The girl had grown a few inches in height, and I mistook her for her sister. She started training. That evening her mother phoned to check because her daughter had said she had swum a mile. I was able to tell her mother it was not exactly true, she had swum 2000 yards.*

*Mistaken identity, but even higher expectations. Twenty five yards at a time one year, 80 times as far the following year with only brief stops as she was asked to change styles or to use arms only or whatever. It amazed even me when I realized this was the same girl who had learnt the basics a year earlier.*

Looking back on setting up my swimming school, I wonder whether my confidence was personal confidence not shared by all of my peers. What was the source of my certainty that I knew how to teach swimming with no training at all? What I had learnt was by observation, experience, and some reading—hardly formal training or a set curriculum. Yet I was confident to teach and successful at it. Perhaps it was to do with my expectations of myself, but in hindsight it more likely reflected ‘other ways of knowing’ in particular, subconscious and bodily knowing.

#### **4.8 Developing assumptions**

By the end of 1962 I knew that I cared about children and mathematics; I felt confident to teach (incident 4.26) and while I had concerns about classroom management (incident 4.24) I believed I could take charge (incident 4.25) and had the required patience. I felt confident with school mathematics and conscious of its role in other subjects. I assumed that mathematics, being based on axioms, was both useful and made-up (later, I would say, a human construction for making sense of one’s worlds).

I thought I had learnt the basic strategies of teaching. At the time these were based on direct instruction influenced by associationism and behaviourism though I had only rudimentary notions of these theories. I saw learning mathematics as requiring doing mathematics and based on the learners’ interests. I valued experiential learning (incidents 4.1 & 4.7), and preferably including open-ended project work (incidents 4.4, 4.5, 4.16, 4.17 & 4.19). Generally I thought that teachers teach and learners



learn, and it was some years before I appreciated teachers as facilitators of learning, or the subtlety of what Mason (2005) said:

It is the teacher's role to organise experience,  
It is the learners' role to make sense of experience.

I was aware that I had been *spoon-fed* at school but it was not clear to me how I might teach learners to learn. Additionally, I did not like the competitive or the compulsory attitudes to learning though I was unsure how to change these in schools. Looking back, I had the over-confidence that is typical of the young and I had not integrated the ideas I had learnt from teaching swimming into my ideas about teaching mathematics.

I was concerned about the role of assessment which I had experienced as unfair (incidents 4.3, 4.14, 4.21 & 4.22), streaming (incident 4.11) seemed inequitable and I wondered about the overall effects of negative and bonus marks. I believed one should learn to *know* rather than to pass examinations (incident 4.21), and saw motivation as based on success, expectations, learners' powers, and experience rather than on assessment.

I had few ideas about curriculum or the aims of education. I knew there was a national mathematics curriculum (syllabus), indeed two—modern and traditional, but I thought about the modern and the traditional approaches mainly in terms of school schemes, textbooks, and lesson planning. My aim was to teach mathematics and I had not considered whether the subject or the learners were more important, but I felt that education should not teach compliance (incident 4.10).

At school I generally assumed that teachers and books were authorities and did not question what was taught. At high school I became aware that curriculum change—the subject magnetism and electricity was replaced by physics, and calculus and coordinate geometry had recently been introduced into mathematics.

I understood that different subjects offered different ways of working and knowing (incidents 4.18 & 4.20), realized that there is much to learnt outside school (incidents 4.1, 4.7, 4.8, & 4.10) and sensed a need for a spiritual aspect to learning. I had pondered some of the bigger questions and developed an interest in the Eastern traditions, but did not expect this to impact on schools. Outside schools I had learnt of the importance of relationship skills in all walks of life. I knew that I did not accept authority easily, I was often argumentative, and my relationships were based more on rationality than empathy.

In hindsight I am surprised that so many of my current attitudes about education and curriculum arose from my early years as a learner rather than from my experience as a teacher and a textbook author which are the foci of the next two chapters.

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### 5.1 Being a teacher

The third stage of my life, my teaching career, is summarized in table 3a.

Table 5a: *Time-line for teaching and textbook writing.*

1963	Assistant teacher		Continued
1964	at Mount Albert		part-time
1965	Grammar School	Wrote two textbooks	university
1966	[taught mainly maths,	('traditional' mathematics)	study for
1967	though some science	with MAGS colleagues.	commerce
1968	and accounting]	Co-authored statistics exs bk	degree
1969	Head of mathematics		
1970	department at Saint		
1971	Kentigern College	Co-authored five mathematics	
1972	[taught only maths]	textbooks with <i>Reeds</i> team	
1973	Head of mathematics	Set up my own publishing	
1974	department at Green Bay	business, Nexus Books, and	
1976	High School [a new school,	co-authored ten mathematics	
1977	taught only mathematics]	textbooks (three series)	
1978	Foundation director (principal)		
1979	and mathematics teacher at	Continued to run my publishing	
1980	Auckland Metropolitan College,	business and distribute	
1981	a state alternative high school	mathematics textbooks until	
1982	1 term~maths advisor	taken over by a larger publisher	
1983			

While teaching I studied part time (as described in the last chapter) and had an overlapping career as a textbook co-author and publisher (see chapter 6). My teaching spanned 20 years in four different Auckland high schools — a state boys school, an independent boys school, a new state co-educational school, and a small new co-educational state alternative school. In this chapter I describe and discuss incidents from these schools and aspects of teacher development I experienced that link with my views of curriculum.

While teaching my view of curriculum shifted towards a practitioner's one. Initially I thought more with subject goals than broader educational ones. My primary concern was planning and that involved finding good learning activities/resources which tended to be sets of textbook examples. At the same time I became aware of alternatives possibilities and attempted to implement some of these into my teaching.

## **5.2 Starting teaching**

My first teaching appointment was at Mount Albert Grammar School (MAGS). A school I had known as a pupil and little had changed since then.

### ***Mathematics***

In the sixties NZ high schools could teach either *new* or *traditional/old* mathematics. At MAGS *old* mathematics was taught. Numerous textbook series were available; some integrated arithmetic, algebra and geometry, and in others these recurred in alternate chapters. At MAGS algebra, geometry and arithmetic were taught, each on different days of the week, with different textbooks, and with unlined scribblers

(exercise books) for each. With *new* mathematics being introduced (in NZ) the subject became more integrated, and while teachers generally see it as such, curriculum ‘strands’ may reinforce the older view.

I was encouraged at MAGS to teach new mathematics to an able year-10 class who had already completed years 9 to 11 work in year 9. The school had not committed itself to a textbook for new mathematics and it was assumed that I would have suitable resources.

*Incident 5.1—Teaching with ‘Mathématique Moderne I’ (Papy 1963)*

*My course was based on the original French version of Papy’s book but my French-language skills were virtually non-existent. For example, I thought ‘cercle’ meant circle, not circumference, and found that ‘disque’ meant circle. However the modern pure mathematics course seemed well received by the class.*

*This experience influenced my use of diagrams, in particular Papy-grams or arrow-graphs as they are generally known, and it made me realize that the context for teaching mathematical concepts can be the structure of pure mathematics itself.*

*When writing textbooks (see chapter 6) I tried to ensure that diagrams were always inserted to help students, though at that stage I had not considered whether it might help their visualization skills more if the emphasis was given to helping them visualize rather than always providing the diagram.*

*Later I saw this experience as reinforcing the notion of multiple representations, not only a Cartesian graph, but also an arrow graph.*

One lesson involved teaching reflexive, symmetric and transitive properties of relations, and equivalence and order relations.

*Incident 5.2—Equivalence classes*

*Using Papy (1967), the properties of relations were considered in words, symbols, and graphically with arrow graphs. We began with simple contextual relations as ‘is the same gender as’ and ‘is older than’ on a set of members of a family. This work*

*was similar to what I had studied in third-year university mathematics, yet these pupils coped with the ideas, indeed, much better than I had done.*

*I was amazed, and resolved to use arrow graphs much more.*

*This experience often comes to mind when I hear Bruner being referred to with statements like “any topic, any age, if taught appropriately”.*

*Teaching unfamiliar work with only one copy of a textbook was challenging. I used the blackboard and discussion more than usual, and assigned tasks that took a considerable time to carry out. I felt that this was better teaching, but did not pursue this line of thought at the time.*

*Later I found myself relating more easily with teachers in the Pacific Island nations and other developing countries where communities could not afford textbooks for all students. However, I also found that many of these schools had trouble getting enough white chalk (much less coloured chalk for arrow graphs).*

*My thinking about tasks that require an extended time period, in terms of costs and student engagement led me to resonate later with Ahmed’s rich learning activities (Ahmed 1987).*

## **Curriculum**

I had visited the school seven weeks before starting teaching and had been given a copy of the mathematics scheme (the school-level curriculum). It was a typical scheme of that period written by a head of the department. It linked the school textbooks with the official syllabus to guide teachers through the textbooks that dominated mathematics teaching. The classes were streamed in terms of general notions of ability and course options, and the school scheme indicated different courses for different streams.

### **Incident 5.3—Planning mathematics lessons**

*Coming fresh from teachers college I assumed I would prepare a lesson plan for each period. No assistance or discussion of lesson plans occurred with mathematics colleagues. After two months I replaced detailed lesson plans with brief notes highlighting the topic, the key ideas, and the textbook examples to be used.*

*My main concern (hardly a reflection) then was to save time. I was aware of four complementary curricula—national, textbook, scheme, and lesson plans.*

*My later reflection was that the head of department assumed that beginning teachers knew what to do. But, would all teachers be able to*

*respond satisfactorily? I know that I made mistakes. I also thought about the lack of suggestions about approaches to teaching. Was this part of the same assumption, or was it because the only concern of mathematics teachers at that time was content? I suspect probably the latter.*

One year after teaching the year 10 class with Papy's text I was asked to teach some of the group who opted for mechanics at year 12. This class had been identified as gifted and had been challenged to complete two years work in one and sit the year 13 external examinations. We used a textbook by Humphrey and Topping (1961). It was large with 22 chapters, and about 50 difficult exercises in each chapter. I had to decide how to cover two-years work in one and resolved to emphasize the basics and assume that these students would apply their understanding to more difficult situations. This meant assigning only the first few problems from typical sets of graded questions. Emphasizing basics worked well, the students achieved excellent examination grades, and my thoughts about emphasizing fundamentals rather than providing a lot of detail with respect to special cases were reinforced. This notion was strengthened years later when I talked with a geography teacher who had modified his teaching to cope with a reduce time allocation for his subject, and again when I read Cox (1998), *the temptation to teach too much material should be avoided*. However, national curriculum documents rarely emphasize basics, they tend to err in the other direction.

I have a vivid memory of the most able student from that class. He was always polite, sat near the back of the room, and usually had a book to read while I was teaching—typically history, philosophy, or a novel in French.

#### *Incident 5.4—Multi-tasking in the mathematics classroom*

*This able student typically and quietly read a book while I introduced a topic to the class and went over difficulties from the previous day's work. When the class was engaged with their new work he would put aside his reading, put his hand up, and ask for help with (say) number 14 from the homework. I never actually completed a problem with him, just a few words which were quickly met with, "thanks, that's enough, I see what to do. Now can you help with number 29?" Finally, "Thanks sir" and as I returned to the rest of the class he resumed reading.*

*I was humbled each term when marking their examination scripts. I checked my mark scheme against his work and noted how his solutions were more efficient than mine.*

*This experience with the class, and in particular with this most able student helped me to see and respect the fact that other people had different ways of working, and that students are sometimes more able than their teacher.*

Another incident related to this period of teaching occurred some six years after I had left the school.

#### *Incident 5.5—The learnt curriculum*

*I encountered an ex-student in the city. We recognised each other and as we approached I thought how difficult he had been in class. He had shown no interest in learning and our relationship in class had not been good. Here I was confronted with a well dressed and personable young man who appeared successful. We chatted, I found he was a sole trader importing cloth—he travelled round the mills of Europe, ordered cloth, then sold it to the factories in New Zealand before it was shipped so he was able to have it sent directly to his customers and avoid the problems of warehousing. His turnover was high and his net income exceeded my salary. I asked him what he had learnt at school that helped him in his business and he replied, "To cope with bastards like you!" I replied "Fair enough!" and we talked a little more.*

*I went away thinking about the hidden and the out-of-school curricula and wondering about what one really learns at school and elsewhere.*

*Even now I wonder, do we ever really know all that we have learned?*

#### **Teaching practice**

MAGS was traditional and my initial concerns and difficulties were with classroom management. I believed there was no place for corporal punishment in schools, I doubted whether it worked, and if alternatives existed for girls then why not use



them with boys. However, this was the early sixties. Corporal punishment was an accepted form of discipline, it was acceptable at MAGS at the time, and in a traditional single-sex boys school it was difficult to sustain my belief in action. I had assumed that I had to earn the respect of students and remembered how some of my own teachers did this within minutes while others had taken weeks. However, I had not thought about this critically and was not sure what caused these differences.

#### *Incident 5.6—Using corporal punishment*

*A student had misbehaved in class and when I put him into an after-school detention he said, “No, I won’t be there, what are you going to do about it?”*

*Not knowing how to react I said that I would cane him and he said, “Well you might as well do that now.” So I did, caning him as hard as I could, hoping that would be an example for others.*

*So much for beliefs. I did feel I had not ‘walked my talk’, however I noted that this action had earned some sort of respect that I did not understand.*

*I continued to feel badly about corporal punishment, but I did use it occasionally while at MAGS. It seemed to me that this incident reflected the hidden curriculum teaching that “might is right”. Or was it the student negotiated curriculum—if so, I would prefer it not this way.*

Of course using corporal punishment as a first resort can backfire, and it did.

#### *Incident 5.7—Corporal punishment, Oh no!*

*I was exasperated; I had set work for the class to do individually, but they would not stop talking. I said, “The next person who speaks will be caned”.*

*A minute later the most well-behaved student in the class spoke to his neighbour. The whole class stopped work and most pointed at him.*

*This was it, I did not think he deserved to be caned, but I had to do something.*

*I told him to go out to the corridor; I took the cane from the cupboard and followed him. I closed the door, told him where to stand, and while he stood on one side of the corridor I thrashed the raincoats hanging on the other side. I then told him not to smile and to go back inside rubbing the seat of his pants.*

*The immediate effect was amazing. The class worked quietly from then on.*

*The incident forced me to re-examine my beliefs. I resolved not to issue general threats of that form and to try alternatives. Luckily the timing of this incident coincided with a time when I was being given more senior work with better-*

*motivated students, and the issue did not occur again, but I did understand the frustration that teachers have.*

*In terms of curriculum as “all planned activity for the classroom”, I should have planned for such an eventuality, but as an inexperienced teacher, I had not. I had used corporal punishment for misbehaviour, but I continued to think that it was not justifiable, and later realized that punishments generally do not work.*

As a parent too my management skills were not the best. I was often tired, perhaps because I was teaching full time, studying at university part time, writing textbooks, and trying to do my share of household chores because my wife was also a full time teacher. Sometimes I lost my temper when my sons had been fighting amongst themselves and reacted using physical force to punish the culprit. This went against my beliefs about punishment, but I was not always able to *walk the talk*.

### ***Technology***

Computing education was developing. Computers were not used in subjects, and computer studies had not been initiated. Computer clubs were being formed, usually by mathematics teachers, but most schools could not afford a computer.

#### ***Incident 5.8—Computing without computers***

*I formed a computer club with the focus on programming. We had no hardware, and used the “Portran” (a mini version of Fortran). We punched pre-punched cards with a paper clip. The bundles of cards were taken to the local bank, were processed over night, and picked up next day with the printouts. As Portran was about formula translation, most programs involved the computer solving mathematical problems. For example, given any three facts about a triangle, solve the triangle or find out as much as you can about it.*

*This opportunity to start computing without a computer was available throughout the country as the Bank of New Zealand had branches or agencies in all major towns. It was a desirable initiative and a good example of a school/industry link. There seemed to be no hidden agenda, costs were minimal, and the service was superb. The students seemed motivated by a desire to learn something different.*

*In hindsight I see the Portran experience as a desirable school/industry initiative, This contrasts with more recent technological innovations where commercial purposes seem to underpin thinking. It also confirmed for me that students often want to learn without external motivation.*

### ***Motivation and teacher expectations***

In terms of motivation and teacher expectations one incident is memorable.

#### ***Incident 5.9—Family names only***

*At school the boys were referred to by their family name. I had two unrelated boys in one class with the same surname. One was the class goody-good the other was a 'rat-bag'. I knew the first name of the better-behaved pupil but at the time of this incident I was not sure of that of the other. Report evening for parents arrived.*

*Two parents arrived and introduced themselves with their surname. I could not ask "Is your son A or B?" as I could not think of B's name, but I assumed that they were more likely to be the parents of the well behaved student. I proceeded to tell the parents what a wonderful pupil their son (A) was. Next morning B arrived at school and asked "Did you tell my parents ..." and repeated nearly all that I had said. I replied "Yes". He accused me of lying to his parents. I thought quickly and rationalised my mistake by saying that I had had the option of saying what he was like, or what I thought he could be like. He paused, then asked "Do you really think I could be like that?" and I replied that I did. Within a week he changed in mathematics classes although teachers of other subjects reported no differences in his behaviour.*

*I had heard of the power of teachers' expectations, but this was my first experience of this on learners. I began to see that bad behaviour was learnt behaviour, learnt at school, and often for the purpose of gaining attention.*

*I resolved in planning to give more positive reinforcement to students.*

### ***Assessment***

Our school assessed with term examinations. The end-of-year ones were used, alongside option choice, to determine class placement in the following year. Many teachers were also involved in marking external examinations. I recall an examiners meeting for School Certificate (year 11) where we marked trial scripts. We were given the mark scheme and marked a trial script, and our marks varied from 44% to 54%. After discussing the marking we remarked the script; the variation was then

48% to 50%. We were told that this variation would not matter as each marker had scripts from a wide range of schools and our marks would be scaled separately. I often recall this when thinking now (40 years later), about standards-based assessment. My other memory of marking scripts was with a Bursary (year 13) mechanics script. The three-hour examination had eight questions. The best script I marked gained 89%, yet the student had no correct answers. In each problem there were one or two slips but the candidate's knowledge of mechanics was superb—so much for right answers.

### ***Extracurricular activities***

While teaching mathematics and science, and later accounting, I organized numerous extra-curricular activities—swimming, lifesaving, waterpolo, gymnastics, table tennis and computing. I quickly learnt that respect earned from extra-curricular activities was of considerable benefit in class.

I accompanied some school pupils on a holiday cruise in the Pacific in the late 1960s. At each port we anchored for 1 to 3 days like a floating hotel while we explored the islands. I recall when a rugby team from the boys on the cruise played against a team from one of the island's main schools. During the feast after the match a teacher showed me around the school.

### ***Incident 5.10—Pacific island school resources***

*The school was a boarding school for about 300 boys. In one classroom I was shown a locked cupboard measuring about 1.2 m x 1.5 m x 0.3 m and was told that it was locked to ensure the safety of the school's textbooks and library. I asked if this was one class's resources, but was assured that it was all the school had.*

*I was staggered. I thought of my own library, it was bigger than that, and the textbooks for my five classes that would not have fitted in the cupboard. I wondered about NZ's aid to the islands and our responsibility to neighbours.*

*Later I thought about how these islands followed the NZ curriculum because they could not afford to develop their own, how professional development was virtually non-existent, how they used out-of-date textbooks given to them by NZ schools that had replaced them, and how there seemed to be a need for a teacher resource-book so that students would not need textbooks.*

*I began to think more about inequity in education, not merely streaming, but that due to ethnic, class, and geographic differences. I wondered what needs to be done and how might curriculum help in this regard.*

### ***Changing times***

While teaching at MAGS new mathematics was being introduced. This involved a *gentle and participatory* approach, schools opted from traditional to new mathematics when they were ready which is very different from the way that new curricula are imposed on teachers today. Only after the majority of schools had opted for change was there a concerted push from the curriculum division for the remainder to change. Throughout this period of change considerable in-service education was available (see 5.6). The initiative had started with pressure from small groups of keen teachers who were aware of overseas developments. Interest built up as mathematics associations organized lectures and workshops. A *pilot* curriculum was developed, and mathematics advisers were appointed to help introduce this curriculum. For primary schools there was a delay while textbooks were prepared centrally, but high schools preserved their right to buy whatever texts they thought suitable. A number of overseas texts were available and these were followed by NZ ones.

### 5.3 Running a department

After MAGS I was appointed as head of mathematics at St Kentigern college (SKC). This was a private Presbyterian boys high school. I preferred the idea of state rather than private schools but my wife was employed at a local school and my children were all happy at their school, so this was a compromise.

The school was traditional and streamed, not very different from MAGS, though the students tended to be from a slightly higher socio-economic class. The Principal knew all 600 boys in the school and their parents; he taught for half the week with much of the administration being done by the bursar. The staff displayed an *ethic of caring* as written about by Noddings (1992), and although the school was traditional and some 'distance' existed between staff and pupils, the school was a happy one. Class sizes were smaller than I was used to, and although this meant that there were not as many non-contact periods, I found it less stressful.

The terms of my appointment made my focus clear—I was to introduce modern mathematics into the school. I was new to the mathematics department but was expected to make changes. The department was small and we worked well together. In my four years at the college I felt that I worked collegially as an agent for change rather than managerially imposing change.

The mathematics staff were well qualified, caring, and somewhat conservative. The early influences in NZ for *new math* had been from the USA, the Illinois group and the Yale University's School Mathematics Study Group (MSG). Their emphases

were on algebraic structure and logic. The next influences had been from the UK and included transformation geometry, one of the first being the School Mathematics Project (SMP) from Southampton University. The Scottish Mathematics Group (SMG) series of texts offered a middle way—a fairly conservative approach, a focus on new content without extreme rigour, lots of examples so that teaching approaches were not challenged, and aimed at all pupils in the cohort. In adopting these texts for the college I assumed that I would be asking the staff to change what they taught rather than how they taught, and I believed this would be less threatening to them. The transition started with year 9 students (form 3, age 13), and progressed one year at a time for five years.

*Incident 5.11—Reflecting on change*

*I assumed that some changes were needed in terms of teaching methods as well as with content, but I saw this as a later step for my colleagues after they felt confident with the content. I attempted to model investigative approaches in my own teaching,*

*The change went smoothly. The teachers initially followed the textbooks closely, but as they became familiar with the material they began to use other resources as well. The teachers seemed satisfied with the changes (which they had assumed were inevitable), and the only discontent was from some older students who felt they had missed what younger students were getting.*

*I wondered if delaying changes in teaching approaches was the right decision. Perhaps it would have been easier to make more changes all at once.*

Although calculators were not emphasized in modern mathematics in the late sixties and early seventies, I had sought a budget increase to buy a set of calculators. There was considerable debate about the cost of these as in the early 1970s the cost of a calculator with trigonometric functions was high—in real terms over 80 times as expensive as they were to be 25 years later. The Principal was concerned about the cost but accepted the need to move with the times.

### ***Extra-curriculum activities***

My involvement with extra-curricula activities included sport and the computing club. I again accompanied twelve pupils on a holiday cruise round the Pacific. One particular event was memorable. On the deck of the ship I saw a boy on a deck-chair reading. As I approached he put his book away. I asked, *What are you reading?* He reddened and said, *The Karma Sutra*. He seemed surprised that I did not confiscate the book. Near the end of the trip I asked if he'd finished and enjoyed his book? He said he had, but found it became rather tedious, then added that it was the first book that he had ever read from start to finish. Years later at a seminar George Joseph said that the so-called unexpurgated version of the Karma Sutra was expurgated and that the original contained mathematical problems for lovers that reflected the Indian recreational perspective on mathematics. I wondered if the truly unexpurgated version might have influenced this student's attitude to mathematics. I also wondered about how reading is taken-for-granted, how it broadens thinking, how learning mathematics relies on it, but how it is not mentioned in the mathematics curriculum.

### ***Aims of education***

While at SKC a book (Munro 1969) was published by our teacher union with some aims for education. These aims influenced my thinking, although not initially my practice. They were, *the urge to enquire, self-respect, and a concern for others* (p 1). These reflected the academic, personal, and social purposes of schooling, and I pondered how such aims might be built into curriculum so they would be attended to.



In hindsight I interpreted these aims too narrowly. I saw enquiry as cognitive enquiry about mathematics, not non-cognitive enquiry, or values, attitudes, beliefs, or emotions. I accepted the need for self-respect but did not consider self-knowledge. I interpreted a concern for others at a personal level, and did not extend this to culture and environment. My focus on self-respect and concern for others was based on my experience with how these influenced classroom conduct.

### ***Moving on***

I enjoyed SKC but a new state school opened in Auckland and I saw this as an opportunity to return to the state sector and, possibly, to do things differently.

## **5.4 Starting anew**

In 1973 Green Bay High School (GBHS) opened. As was usual with new schools in NZ at that time, it was co-educational, it opened with third-formers (year 9 pupils), and expanded one year at a time over five years. I was keen to move and successfully applied to be head of mathematics. A month before our first staff meeting we were asked to read *Teaching as a subversive activity* (Postman and Weingartner 1971). At GBHS I began to learn about education rather than teaching, and to teach students rather than mathematics.

The principal's philosophy regarding no uniforms, the development of social and moral as well as academic dimensions, the lack of corporal punishment (it was common in many other schools at the time), the lack of streaming or information ranking within classes, and the lack of prizes for achievement, are outlined in his

book (Mann 1987) that he wrote after retirement. These ideas were discussed at meetings of heads of departments and these meetings were a wonderful source of professional development for me. At the practical level the school organisation had three foci—curriculum, guidance and administration. I was mainly involved with curriculum and administration but came to appreciate the complexity and the interconnectedness of the three foci. I valued the way the Principal delegated tasks—he did so completely and with trust.

### ***Aims of education***

With no uniforms students were expected to develop responsibility for dress. Picking up rubbish was not a punishment, as the principal said, *If we are proud of our school and environs then we will naturally keep them tidy*. Everyday at lunchtime the Principal delighted in walking around the grounds, chatting with students, and picking up rubbish with them. The two evident principles seemed to me to indicate *respect for all and responsibility for all*.

### ***Incident 5.12—Reflecting on aims***

*Respect and responsibility are typically mentioned in the aims of education, but this was the first time I had heard a Principal talk of these things in quite this way. I began to see that the informal curriculum was as important as the formal one.*

*This was the first school I had taught at where aims were discussed explicitly and where approaches and aims within subjects were meant to fit within these broader aims. This caused me to think much more about the purposes of education and how mathematics lessons might contribute to them.*

### ***Teaching***

I had obtained permission to trial a new textbook series that I co-authored with colleagues from other institutions (see chapter 6). For the first year at each level I

followed the draft text closely to identify areas that needed to be changed. The classes were not 'streamed', and I had only taught streamed classes before. I found teaching seven year-9 classes in the first year stressful. It was difficult at the start keeping the classes on similar work, but after two months I moved different classes to different topics in order to stay sane. After two years of trying to cope with the range of abilities in unstreamed classes I designed an individualized programme using our textbook as the main resource but basing the programme on mastery learning that fitted with current behavioural notions about learning.

#### *Incident 5.13—Mastery learning*

*The individualized mastery programme was designed with a set of cards to guide students through the text at their own rate. I knew that having high expectations of all students had a generally positive effect but I worried that I was not extending gifted students nor allowing less-able students to keep up by concentrating on fundamentals and avoiding supplementary or very difficult tasks.*

*I did not realize how important social interaction was and only at my next school did I restructure this programme so that groups in class rather than individuals progressed together. I also had not realized the advantage I was giving to pupils with good reading skills who coped well with the programme compared with those who responded better to oral instructions and teacher-directed lessons and working in groups seemed to help remedy this.*

*I had assumed that mastery based on behaviourism was reasonable but began to question this as I began to see learning from other perspectives.*

*With hindsight I know that mastery learning can be richer than my programme, and can help with learning-to-learn skills.*

At Green Bay our librarian talked to all heads of departments about resources and I provided a list of books that she obtained. A year later she told me they were not being used and asked me what might be done about this. I thought about the place of the library in learning, discussed this with the mathematics staff, and designed task cards for the library so that a teacher could take a whole class to the library, and give them different projects to do at appropriate levels that built on their interests with

each project referencing a few pages of a suitable book. This seemed successful and I later ran a workshop for the mathematics association about this initiative, and wrote a brief descriptive paper describing the project (Begg 1975). This experience made me aware of the potential of the library as a resource for learning mathematics, and of the value of project-based learning. While it only slightly changed my practice, it was a start, and it led some teachers to use more project work.

To brighten classrooms we purchased a large number of mathematical posters and put ten in each room (the informal curriculum). One or two were stolen by students but this did not upset me as I thought, *Wow, they want some maths posters in their homes*. I realize now that I should have followed the purchase of posters with more emphasis on students' work being displayed, unfortunately I did not.

The need for a variety of approaches to teaching was evident. I purchased a number of mathematical games for each classroom. In the first year with these each teacher devoted a period per week for *informal* lessons using the games. After a year when reflecting on the value of these games for learning, the department decided to stop the informal period and integrate the games into the teaching programme.

At GBHS I wanted to equip a classroom with calculators as I had done at SKC. This required a change to my department budget and I approached the principal thinking that the main question might be about the cost. Instead I was surprised by his first question, *What is the educational advantage?* Having justified the use of calculators as a tool replacing slide rules and logarithms I got the go ahead.

## ***Motivation and punishment***

At GBHS there were disruptive incidents in class and I was not certain how to handle these or whether to punish those involved. When discussing punishment the principal had said, *detentions don't work, it's always the same students in detention*. On one occasion a student was misbehaving in class and I was wondering what to do.

### ***Incident 5.14—A good talking to***

*When students misbehaved and one could not cope with the problem it was normal to send boys to the senior master or girls to the senior mistress. One boy had been misbehaving for some time and I intended to send him to the senior master.*

*As I said to him, "Go and see...", he interrupted and said something like "I could go and see the Principal." I replied, "Yes do!"*

*He returned ten minutes later. He was very cheerful, sat down and behaved perfectly. I asked him what had happened, he smiled and said "The head and I had a talk".*

*Later that day I thanked the Principal and asked him what had occurred. He said they had talked, discussed the notion that a student was responsible for his own learning, and he'd asked what the student's future aims were. I wondered if I could ever react in such a reasonable way.*

As part of trialling textbooks I had a regular chore collating cyclostyled chapters of the draft for all the pupils in the year's cohort. I used this weekly chore as a detention task for the more unruly pupils from my classes. I did not think it would change their behaviour, but I needed assistance with the collation.

### ***Incident 5.15—Punishment or otherwise?***

*One girl always seemed to be in my 'collating' detention. I spoke to her about this. She said, "It's a game. If I behave badly you put me in detention, then I stay and help sort this paper. That's more pleasant than going home". When I invited her to stay and help without being in detention her behaviour improved markedly.*

*This caused me to rethink the place of punishment in classroom management and the motivations that pupils have to adopt particular behaviour patterns.*

*The ineffectiveness of punishments was later reinforced for me when reading Thorndike's (1902) theory of associationism in which he talks of rewards as useful but punishment not.*

Each year many students had their names written in the *honours* book, but prizes were not part of the school's emerging traditions; students were seen as growing, external rewards were considered irrelevant and intrinsic motivation to learn was seen as important. The philosophy underpinning punishment and motivation was summed up by the principal's recollection later, *Schools must look to the real needs of students rather than take comfort in the measureable* (Mann 1987).

### ***Another move***

Near the end of my fourth year at GBHS the Principal showed me an advertisement, and said, *Here's your next job*. I jokingly asked if he was trying to get rid of me, he assured me that he would be sad to see me go, but reiterated, *it is your job*. The position was Director of a new alternative high school that was to open. I knew that opportunities such as this did not occur often so I applied.

## **5.5 Leading others**

I was appointed Director of Auckland Metropolitan College (AMC) in late 1976. It opened in 1977 with 80 students, increasing to 100 from 1978. As Director (Principal) I thought I had *made it*. The expectation was that the school would be innovative. I assumed that a school meeting, based on the *Summerhill* model (Neill 1962) would be established for decision-making and my role would be to provide input and ideas to meetings, ensuring that both sides of discussions were heard (even when that meant putting forward perspectives I did not agree with), and either implementing legal meeting decisions or bringing up the legality issues so that the meeting could reach alternative decisions.

I had expected most students (or their parents) to ideologically prefer alternative education but soon found that nearly half the students simply disliked traditional schools. However, staff, students, and parents looked at education broadly, not just in terms of subjects. AMC's aims together with *the urge to enquire, concern for others, and self respect* (Munro 1969, p. 1), and other purposes for education were discussed and my thinking was extended.

The community committee that lobbied the government to set up the school had determined the school's philosophy. The school developed as an alternative school, becoming more like *Summerhill* than the *school-without-walls* that the original committee had envisioned. I saw this as responding to the students' desire for a home base and a place to identify with, and as a convenient place for teachers who were expected to teach the standard curriculum to classes sitting external examinations. The philosophy was summarized in the aims of the school, and these, with strategies, are paraphrased from a report (Begg 1980) when AMC was being evaluated.

### ***Aims***

The aims of the school had been clearly stated in the initial prospectus as:

- to promote interaction between the college and the community
- to involve the students more directly in determining his own education
- to develop critical acumen
- to develop communication skills
- to develop responsibility

AMC's specific aims were similar to those of other schools; but we consciously initiated strategies to achieve them, these included:

- Interacting with the community
  - Work experience (including community service work)
  - Participation in community courses
  - Using community places and the environment for courses and camps
- Determining one's own education
  - School programme based on 6-week blocks with a new *course catalogue* each block and free choice for students to plan their programmes (Courses in the catalogue arose from student/staff discussions)
- Developing critical acumen
  - A philosophy class in the first two years of the college's life
  - An open atmosphere with debate in classes and at school meeting
  - Students self-assessed and self-reported after each six-week block
- Developing communication skills
  - Teaching approaches (especially in social studies and language)
  - Human relationship sessions
  - Group work and discussion in meetings and classes
- Developing responsibility (Making decisions and living with consequences)
  - School meeting with democratic decisions made by students and staff
  - Students determining their own education
  - Student committees interviewing and (virtually) appointing staff
  - Responsibility for free time
  - Responsibility for dress



*Incident 5.16—Reflecting further on aims*

*Reflecting on these aims and strategies, I believe that we emphasized experiential education and participatory-democratic education, as well as inculcating thinking skills, social skills, and developing initiative and responsibility.*

*In hindsight I wonder if emphasizing applied philosophy for students of all ages in the school (as achieved elsewhere, for example, at Buranda State School in Brisbane (Vaseo & Hinton 2005)) might have contributed to students' thinking and spilled-over into other subjects.*

*Our emphasis was on the cognitive and social (and emotional) dimensions, but not on the spiritual. Aspects related to identity were discussed but insufficient quiet time seemed to me to be provided for opportunities for reflection, stillness, and the development of awareness of self.*

*I continue to wonder about the limits and emphases that schools and educational systems impose in terms of the perceived needs of students in a changing society with respect to knowledge and economic progress rather than personal, social, emotional and spiritual dimensions that are alluded to but rarely addressed.*

Taking to heart the notion that one should learn from one's mistakes, I tried to ensure that AMC was a safe place to make mistakes and to learn from them. What was needed was to provide second and third chances. To give the minority of students who arrived at AMC after expulsion from another schools another chance I did not share the fact about expulsion with other staff unless a potential danger existed. Once I asked staff to select from a short list the students they thought had been expelled, the staff members' guesses were all incorrect—second chances seemed to work.

The six-week timetable was another second-chance strategy. If a student made a wrong decision, then six weeks later they had an opportunity to reverse it with no loss of face. In mathematics this was especially evident. Many students initially disliked mathematics, opted out, but six weeks later opted back into the subject. I assume that this was because they thought it would help in their future, and because other students told them it was not taught as it had been in traditional schools.

### ***Administration or democratic education***

For me, school meetings were the most important aspect of AMC. Students and staff benefited from them. At these meetings administrative matters, discipline matters, school rules, course, ... , everything was up for discussion. Sometimes older students complained that they had heard arguments before, but they were reminded that new students had not. Often students were reluctant to voice opinions that differed from staff views, so staff (myself in particular) often put forward alternative views to open debate. The principle was one person one vote including mine, and I had said that I would resign rather than veto a decision.

I saw student involvement in administration, particularly at school meetings, as part of curriculum. It contributed to a sense of belonging, to experiencing participatory democracy, to learning management skills, to involving people in *real* decision making, and to learning to be responsible. I am aware that teachers often have class meetings but compared to a school meeting their powers are limited. I accept that school size makes a difference but perhaps the advantages of such meetings suggest a need to consider smaller schools or alternatively schools within schools.

In addition to school meetings, students worked on various tasks such as timetabling, camp planning, and staff selection. I was always impressed by their responsibility, their common sense, and the contributions they made. This made me aware of how limiting curriculum can be if it remains fixed on subjects rather than on living.

### *Incident 5.17—Appointing staff*

*On one occasion three students and I were the committee to select a staff member. (The interview committee sometimes comprised students only.) We had short-listed two applicants to interview, these took place, and the deliberations began.*

*I thought that candidate 'A' was more suitable and would fit in well. The students thought candidate 'B' was better and that 'A' would not last long. I was using reason, and the students were more intuitive. We accepted candidate 'B'.*

*Candidate 'B' accepted the position, stayed for a considerable time at the school, and did a very good job. I found that candidate 'A' had successfully applied for a position in another school which I believed would have been much easier for her than our school but she only lasted there for one term, was very stressed, and left teaching.*

*So much for reason; the students reinforced the value of instinct and intuition. My skills in that area were not as well tuned as theirs were. I wondered whether the emphasis that I put on rationality actually limited my intuition, and I wondered about my rationality?*

*An example of students/learners powers, but one that curriculum seems to ignore by emphasizing only rational thinking*

### **Teaching**

Full-time staff taught for 20 hours each week and as Director I taught mathematics for 15. Many students wanted traditional subjects, but in non-traditional ways, and we also offered non-academic courses. Each student chose their courses for the 6-week blocks and courses were designed with as few pre-requisites as possible.

I needed to ensure that students could opt in and out of mathematics. I used the mastery programme from GBHS but shifted the emphasis from the individual to students working together in small groups. In the long run I found it encouraged students to develop the skill of learning from printed matter, although some students who disliked reading were disadvantaged.

During my seven years at AMC I learnt a lot from other teachers about other subjects in the curriculum. All the teachers were memorable but four I especially remember.

A teacher of English found senior boys did not like poetry. She asked them to bring guitars to school, taught them some Leonard Cohen songs, then produced a book of Cohen's poetry assuring them they knew enough poetry for the examination. I also remember that she nearly always responded to questions with more questions thus encouraging her students to think things through for themselves.

One science teacher focussed very much on the interests of her students, made much of her work project-based, and seemed often to be facilitating six or seven different classes at the same time with multi-level and multi-subject teaching.

An art teacher (with no formal art qualifications) taught the subject well, inspired most students, and managed to get his top student to 100% in the external examination. He learnt by observation; when the school purchased a pottery wheel he invited a parent who was a potter to give the first lesson as he had never used a wheel himself. He watched, and that afternoon he threw his first teapot (which was used in the house he shared for some years). Perhaps his most memorable teaching was when students requested a music class. He said he would teach one if the students made a commitment to 12 rather than 6 weeks. In the first block the students each made a musical instrument and I remember saying to him, 'how are you going to teach them all to play as you cannot play all those instruments'. He smiled and replied, "you know that, and I know that, but the students do not". And at the end of the 12 weeks the students performed for the school at a school meeting.

The social studies teacher wanted a cross-section of community people to talk with his students. However he found that some people lacked the confidence to prepare a talk so he changed the format. Visitors were asked not to make a formal presentation, instead to respond to student questioning, this also meant that the visitors would address what the students wanted to know. Visitors I interacted with all enjoyed these sessions and the students showed their appreciation by asking for the class to continue in future 6-week blocks. One notable guest was the Minister of Education, he arrived and told me that he could not stay more than 30 minutes. After 25 minutes he rushed back into my office, asked to use the phone, cancelled two appointments and stayed with the class for a further 90 minutes answering their questions.

Interpreting curriculum very broadly, building on the students' interests, questioning rather than telling, having high expectations and confidence in their ability to learn, and using different approaches to ensure inclusiveness—but I must admit, these were not features of teaching in my mathematics classes.

### ***Assessment***

School assessment was not high stakes and, in line with the school's aims, we wanted pupils to take more responsibility. Accordingly, every six weeks students filled out their reports, staff countersigned subject comments, and the students took their reports home. This seemed important if we were to encourage life-long learning, as self-regulated learning requires self-monitoring (or assessment). The pupils responded well. Most began by being too hard on themselves and countersigning teachers suggested changes that could be made to the reports.

We did not have school examinations but senior classes usually asked for a practice session before external examinations were held. A number of teachers gave two practice examinations, the first, question by question so that students could see what was expected and adjust their examination technique, the second under normal examination conditions. The lack of previous examination experience seemed to make no difference to the students' results, and students seemed quite relaxed about the examinations.

Year 12 students could have a pass *accredited* by their teachers in the external examination if their standard was high enough, the other students still being able to sit the examination and pass if they reached the required standard. While the school had this right to *accredit* the year 12 students annually voted whether or not we would exercise the right. It interested me that when the class opted not to accredit they worked more cooperatively and the pass rate was higher. When we accredited they were more competitive and collegiality was not as apparent. I accept that the sample size is too small (20 each year) to make any claims, and that the cause and effect relationships could be either way—a cooperative class voting for no accrediting, or because there was no accrediting they worked more cooperatively.

Another aspect related to assessment was student references. As Principal I wrote references for school leavers and was aware that these are often more important for employers than academic results. I developed a multi-choice template to ensure that I covered all relevant aspects of each student's life and I structured the first draft in an interview session with them. This was partly to ensure that I included community

aspects that were not related to the school so that students would not be disadvantaged when compared with students from larger schools that offered a broader range of activities. Using this template as a guide I took the customary stance of only writing positive things. One student had not attended many traditional classes, but had participated in camps and had organised classes helping other students to make camping gear. He responded to a remark about class-work with: *In three years I've been to 39 school camps—surely that is a record.* He received a very full reference about his broad range of experiences and interests with non-traditional learning activities. This also reinforced for me how much many students valued so-called extra-curricula activities.

### ***Relating to others***

There were no separate staff facilities and rules applied to staff and students. The relationships between staff and students were close and we all used first names.

#### ***Incident 5.18—Applying for a job***

*A friend told me he had offered a job to one of our third-year students. He laughed and told me that at the interview he had said to the student,*

*“Now, you are at AMC so, do you know Mr Begg?”*

*The student replied, “No, I’ve never heard of him”.*

*My friend said, “But isn’t he the school principal?”*

*The student replied, “No, the principal is Andy.”*

*We had used first names to help break down barriers between staff and students, but had assumed that everyone knew family names too.*

*Ten years later, when working at university, I found that similar informality also led to a much healthier working relationship, (but again, I am not sure about cause and effect).*

Another incident about relationships occurred with members of the staff.

*Incident 5.19—Delegation, and ...*

*Three female staff members asked to see me after school. They started by saying how much they enjoyed working at the school, how they enjoyed having responsibility delegated so completely, but they felt that they deserved to be thanked occasionally. I was taken aback and said that I had assumed that they were professionals and would want to just get on with the tasks.*

*I knew that I had admired their high standard of professionalism, I had just not thought about the personal needs for affirmation or thanks.*

*Thinking about people more generally and my taking-for-granted attitude I realized that this was contributing to poor quality personal as well as professional relationships and I needed to do something about it.*

A third incident involving relationships occurred when a student was in my office.

*Incident 5.20—Comforting a student.*

*A student arrived at school about 40 minutes before the school day started. She entered the office crying, and was obviously upset. She told me about her family problems, her parents were splitting up and shouting at each other. I acted 'in loco-parentis' and put my arm round her to comfort her. We talked about the situation from her perspective and from that of her mother and father. She slowly cheered up and after about 30 minutes seemed ready to go out and interact with other students. While this had been going on our liaison inspector had passed the office, seen what I was doing, and had been talking to another staff member. Later she spoke to me and said I was putting myself at risk by touching a female student. I reacted and said that if a complaint was made and I was pushed out of teaching for doing this then I was happy to leave, but while I was teaching I would care about students.*

*As I thought about this some more I appreciated the well intentioned advice but thought 'what a sorry state society is in when touching someone is regarded as inappropriate behaviour'.*

A particularly interesting observation about relationships at AMC was how students related to others as people. It was not a matter of having friends of the same gender and a 'special' friend of the opposite (or the same) gender. It was very healthy and it was great to see mixed groups enjoying a range of activities without the inclination to pair off.



### ***Thinking about moving***

My feelings about children, as parent, teacher, and director at this stage of my life were summarized by a verse from *The Prophet* by Kahil Gibran (1926, p 20):

Your children are not your children.  
They are the sons and daughters of Life's longing for itself.  
They come through you but not from you,  
And though they are with you they belong not to you.  
You may give them your love but not your thoughts,  
For they have their own thoughts.  
You may house their bodies but not their souls,  
For their souls dwell in the house of tomorrow,  
Which you cannot visit, not even in your dreams.  
You may strive to be like them, but seek not to make them like you,  
For life goes not backwards nor tarries with yesterday.

Recalling my time at AMC I remember staff talking about caring and learning from mistakes, but not about learning theories. Behaviourism was still generally accepted in NZ, but there was the obvious influence of Neill (1962), evidence of democratic education, more project work than in many schools perhaps reflecting the influence of Dewey (1916, 1938), more discussion, and near encounter-group activity which resonates with the work of Rogers (1969).

AMC value from a curriculum perspective was that it was able to experiment with new ways of teaching and different subjects. By pushing these and other boundaries I saw the school as legitimating less radical innovation in other schools. I became totally convinced that many teachers were capable of and wanted to develop curriculum to suit their students in their schools. Some other schools did do some things that AMC was doing (although not necessarily because we were or to the extent that we were), but we also allowed other schools to move in more conservative directions; one principal was reported as having told two parents, *if this is not what you want, go to that 'other' school down the road.*

While I was at the school the politics of education had not swung to the right with the emphasis on accountability as it did later. When this swing occurred many of the liberal activities were harder to achieve within the regulations, and this contributed to the school's eventual demise many years later..

I enjoyed my seven years at the school but towards the end I felt we were not breaking new ground and it was time for a new Director to bring in fresh ideas and for me to move on. I had been seconded for one-term to the Department of Education as a mathematics advisor, I had unsuccessfully applied for other principals positions, then successfully applied for a position in the Government's Curriculum Division (which is the focus of chapter 7).

## **5.6 Developing as a teacher**

As a teacher my professional development took many forms including:

- part-time university study
- school meetings (staff, departments, and heads of departments)
- night-class lectures
- mathematics association lectures, meetings, and workshops
- teacher refresher courses (week long residential vacation courses)
- mathematics magazines
- writing with colleagues
- working parties at national and local teacher centres
- external examination marking panels
- principals' meetings and conferences

The main form of teacher development provided by the Government was the teacher refresher courses. Most of these were concerned with helping teachers implement changes to curriculum, the focus being mainly content, though sometimes alternative teaching strategies were discussed or modelled. New mathematics was introduced over ten years and during this time there were two or three such courses every year. Initially I attended some of these as an interested participant, later I lectured at some of them and realized that preparing a lecture for a professional development session was more beneficial to me than to the session participants.

Two vivid memories from these courses are summarized in the following incidents.

#### *Incident 5.21—Teachers not solving problems*

*One lecture I attended was about problem solving. As the room filled the lecturer pointed to the blackboard and suggested we get started. On the left side of the board was a list of about ten approaches for solving problems (from Pólya 1957). On the right side were four problems for us to do. Being confident mathematics teachers we all started with the problems. After 15 minutes the lecturer asked if we had completed any of the problems. He found that none of us had and suggested we consider the list of approaches. Within ten minutes most of us had solved the problems, and we discussed what had happened.*

*This was the first time I considered how education develops some learner's powers but ignores or even stunts others. We had been inculcated into traditional algebraic methods; we had not thought divergently about the problems.*

*I often remember this incident and wonder how much the curriculum encourages 'one-track' thinking, and what can we do about it.*

*When I reflected on problem solving in the curriculum I noted that it was only a word or two in the new maths curriculum, then, in the 80s it was a paragraph or so in the 'introduction', and in the 90s it was a significant part of the 'process strand'—an evolving status.*

### *Incident 5.22—Learning graph theory*

*At a five-day refresher course one lecturer decided that teachers should experience being learners. He had one session each day.*

*Day 1: There was an hour lecture on graph theory. This was new to most of us. Some participants took notes. At the end of the session the lecturer said he had forgotten to tell us that on day three there would be a test on the topic. That evening a number of teachers tried to recall the lecture and summarize the ideas with notes.*

*Day 2: The lecturer continued his teaching for an hour. The atmosphere was very different, everyone was attentive, taking notes, and asking questions.*

*Day 3: We sat the half hour test; and the lecturer promised results next day.*

*Day 4: During breakfast the results were posted on the notice board (this was in the days before the privacy act came into force). When the session began the lecturer started by asking if we were happy with our marks. Most of the group were not. He then began to go through the questions showing how he had been introducing the topic gently but there was much more behind it, and, for example, in question 1 when asked how many ways ... and most of us had replied, 2, 3, or even 4, or 5 there were in fact over 12 ways. After he had gone over a few more questions we were all rather quiet. He again asked if we were still unhappy with our marks, only two said they were, and he arranged to see them privately.*

*Day 5: The presentation started with a transparency of our results, and another of random numbers. The link was obvious and the lecturer said that our papers had not been marked. The question was, how did we feel. Much discussion followed. One teacher admitted that she had not been sure how she had got the mark as she had felt so insecure that she had not put her own name on the paper, but she assumed she had been found out, being the only one to do this.*

*I had been on the organizing committee for this course and knew what was planned, but I was surprised how the test, with no significant consequences, changed how teachers responded. When I thought about it I saw the test not as motivating, but the teachers' fear of 'loss of face'.*

*Later I thought more about students in my classes, in particular Polynesians for whom loss of face or shame is important. I wondered about summative assessment (school examinations and external examinations) and formative assessment (testing within my mastery programmes), and questioned the usefulness of such forms of assessment in terms of motivation or usefulness of results.*

The Auckland Mathematics Association was active throughout my teaching career and a group of us who had been through teachers college together joined, attended lectures and workshops, and were soon appointed to committees and subcommittees. The association initiated the *New Zealand Mathematics Magazine* and I became its business manager from late 1963 to 1970, and editor from 1971 to 1976. My

involvement with the magazine and with textbook writing (from 1965 to 1978, see next chapter) made me aware of the place of journals and resources in development.

Staff and department meetings at my first two schools had focussed on organizational and administrative matters. This changed in the next two schools. I slowly realized that professional interactions at school level can result in immediate experimentation and change (curriculum development), and was more effective professional development than attending courses or reading and writing, though these activities were often the sources of ideas.

### ***Learning outside formal education***

During my 20 years of teaching (and in the following years) my life situation changed and I built a number of houses using an architect friend with whom I had been at University. I learnt a great deal from our interactions. Whenever a plan was discussed I would ask questions, *Why this ... ?* and *Why not that ... ?* He was patient, he gave me reasons and his explanations were sensible and appealing. He explained how the golden ratio was applied, how apparent space and actual space differed, and many other architectural notions. I became very interested in architecture and read widely on it. He taught me (or was that from my reading?) how to write a brief for a house, not by imagining the finished project, but by taking a walk through an imaginary house and writing what might happen in each room. He also taught me how important it was to give young architects a chance and insisted that my son who was an architectural student should be involved with my projects.

My architectural experiences were experiential education, real and meaningful projects, discussion, collaboration, all aspects that make learning successful. They were based on knowledge of social needs, aesthetics, design, construction, and regulations and made me think about the school curriculum and how rarely we have multi-discipline activities. Supplementing this experiential learning was my reading, the most significant book being *A pattern language* (Alexander, Ishikawa, & Silverstein; with Jacobson, Fiksdahl-King, & Angel 1977). This book had a way of looking at architecture that differed from those in other books, I often thought about the need for a similarly structured book in mathematics education, and was delighted when in 2001 a colleague said the same about this book.

Learning and reading about architectural design is one thing, but the experiential learning from living in well-designed spaces is another. In schools, architecture is part of the hidden curriculum and I wonder about our priorities when the amount spent on buildings for tertiary education is so different from that spent on pre-school institutions and on primary schools. Ideally all students should experience well-designed buildings but many do not have that opportunity. Perhaps, as Burns & Smith (2005) have indicated, more attention is needed when ‘designing spaces for learning’, and to me this is also needed when upgrading established buildings.

Another incident outside formal education was related to windsurfing. I had had one lesson, then taught myself from a book. I had helped my sons learn, then two years later three nephews (aged 18, 17 and 15) wanted to learn. I told them, *the book says one to two hours of frustration, then you should be sailing*, but they were still keen.

### *Incident 5.23—Windsurfing*

*One by one my nephews went out on the windsurfer. I paddled a surf kayak beside them and gave them instructions. We swapped crafts when they were exhausted. The younger two struggled through their first hour or so then managed to sail. At that stage the older one had not been on the windsurfer but had paddled alongside me, listening to what I was saying, and repeatedly asking, "Why?" I gave him my rationale each time, but did not expect the information to make much difference. I soon found otherwise. From first stepping onto the windsurfer to sailing took about 30 minutes, and during that time I hardly said a word.*

*Learners learn differently! He was consciously aware of his body and able to integrate bodily and cognitive notions. I was amazed.*

### ***Relating to others***

Relationship skills have been important in my professional and personal life. I had found it easy to relate to professional colleagues, and as the years progressed and I moved to schools where staff and students were closer I found myself increasingly empathetic with students. However, my personal relationships were not so successful and I accept one son's criticism that my parenting skills were not the best. My first marriage had ended amicably while I was teaching and I had later been in a second relationship but that had crumbled. At the end of my school-teaching phase I reflected on our changing society and the way that my life seemed not atypical. I thought about relationship education, both personally, what do I need to learn, and professionally, what might schools do for students? I wondered whether relationship or social education should be taught separately from other subjects where one learns about others, negotiation skills, seeing other people's perspectives, and so on. This concern, from both a personal and an educational perspective, has arisen periodically through the later phases of my life.

## **5.7 Reflecting on curriculum**

For me mathematics had become more integrated, especially after new mathematics was introduced (incident 5.1) and my appreciation of the value of multiple representations (incident 5.1) developed. Statistics had become part of school mathematics. Mechanics had returned to physics which is where I believed it belonged, though it had provided meaningful contexts for mathematics. Calculators were popular and I had used them in schools and pushed for them through textbooks (see chapter 6). Computing had been initiated in schools by mathematics teachers including myself (incident 5.8), but were now being seen merely as a tool.

My lesson planning (incident 5.3) had started pragmatically with an emphasis on content. I had noted the value of extended activities (incident 5.3) and the one task per lesson approach that Stigler (1994) later discussed, but rarely used these within my teaching. I moved from an individual focus to group work and varied my teaching a little by using the library, posters, and games. My main mathematics curriculum thinking occurred as part of textbook writing (chapter 6). I believed my teaching was improving and I was learning more about classroom management (incidents 5.6, 5.7, 5.14 & 5.15)

I accepted a need for assessment although it did not contribute to learning, I was aware of the extent of variation in assessment, and the way that some teachers emphasised answers while I tried to emphasize ways of working and to accept alternatives (incident 5.4). I knew that teachers' expectations of students were important (incident 5.9), and my visit to the Pacific had made me more aware of the



inequities in resource provision (incident 5.10) which I assumed influenced achievement. I thought my teaching was successful but knew that the learning outcomes were not always as intended (incident 5.5).

My focus shifted from mathematics to students as my thinking about aims moved from efficiency and caring, to responsibility, thinking (incident 5.16), democracy, and school meetings (incident 5.17). Accompanying this was an increasing concern about working towards general aims (incident 5.12). I believed that students needed to be respected and trusted; but learning to be trusted can involve making mistakes, so second and third chances need to be provided.

I had been involved in many professional development activities and acknowledged the importance of prior experience in teacher learning (incident 5.11). I had witnessed some dramatic incidents at teacher courses (incidents 5.21 & 5.22) though they hardly impacted on my teaching. I learnt from my colleagues at AMC about building on students' interests, using projects, and having high expectations, but again did little to change my approach with mathematics teaching. My appreciation of experiential learning was enhanced by what colleagues were doing with work placement and school camps, and this was reinforced outside school by my learning about architecture and about different ways of knowing (incident 5.23).

I felt that my professional relationship skills were slowly improving (incidents 5.18, 5.19, & 5.20), I felt professionally competent and confident and enjoyed the way my career was moving, but was aware of a lack of progress at the personal level.



## **Chapter 6 Writing textbooks**

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### **6.1 Starting writing**

My writing career in mathematics education started in my second year of teaching with an article for the NZ Mathematics Magazine (Begg 1964). That same year two colleagues, the principal (a former teacher of mathematics) and the head of our mathematics department, invited me to co-author a textbook with them. As a year-two teacher I was surprised and flattered by this invitation and I accepted. This decision began a parallel career involving more than anticipated; I co-authored 18 mathematics textbooks during 1964–1978 and published ten of these in 1973–1983.

I was aware that in the USA writing textbooks was seen as writing curriculum.

However, in NZ, Australia, and England the textbook seemed to complement the curriculum, it was a resource, albeit the main one, and was used with other resources.

For me textbooks were resources for teachers and students that:

- interpret the curriculum
- organize a teaching order

- suggest teaching strategies
- list examples for teachers to select from
- provide students with help for their learning.

This seemed similar to my colleagues' views though when we had started in 1964 our view of teaching was teacher talk, worked examples (with some discussion), and practice examples.

At this time in NZ most schools taught traditional mathematics and taught arithmetic, algebra and geometry from separate textbooks, although some were beginning to change. Decimal currency was to be introduced in 1967, and a need arose for a new arithmetic book for years 9 to 11. There had been little debate about metrication and the textbook was written using mainly imperial units.

Our philosophy was evident from the preface (Nairn, Hall, & Begg 1966, p. iii).

The purpose of this book is to provide a suitable course in Arithmetic for three years of secondary schooling for the average pupil. There should be sufficient work for school and home for this student, assuming that two periods per week is the allocation for Arithmetic.

The higher calibre groups will only do a limited amount of arithmetic in their third year and there should be sufficient work for them. The lower calibre groups will find ample to do if the concentration is on the easier examples.

It is suggested that Part 1 be covered in the first year though some may choose to omit sections of Chapters 1, 2, 3, and 14.

Part 2 will provide work for the second year and, again, sections of Chapter 26 could be omitted.

Part 3 is mainly revision.

Rapid Tests have been provided to keep the elementary processes in the forefront of the pupils' minds. These tests should be done at the rate of one per teaching week, and for further revision, they could well be attempted more than once.

Revision papers are provided and these are most useful shortly prior to examinations whether term examinations or half yearly. They provide an overall coverage of the chapter topics.

Arithmetic is best learned by the pupil doing a multiplicity of exercises. If a pupil does all or most of the exercises in this book it is hoped that he, or she, may have reasonable ability in Arithmetic and understanding of the principles involved.

Our assumptions were clear: streaming, selection of appropriate examples, revision, examination preparation, and learning arithmetic by doing many exercises. I did not think of doing many exercises as drill *and practice* but rather as drill *for understanding*, and I presumed my fellow authors thought the same.

Writing was a collaborative task but some early decisions could not be changed easily. Textbook production in the sixties needs to be considered in terms of the available technology—carbon paper or stencils instead of copying machines, hand written drafts and no computers for word processing or diagrams. We met regularly to discuss drafts, we worked through the exercises for the answers and noted any ambiguities in the text and the senior author wrote the final draft of each chapter (in longhand) to ensure writing style consistency. The discussion about the chapter drafts was useful professional development, it was the first time that I had worked with colleagues where we intensively critiqued each other’s work.

One incident in particular stood out for me.

*Incident 6.1—Teaching logarithms*

*We were discussing logarithms and had decided to use a standard form column in addition to the number and logarithm column. Thus our working was:*

<i>number</i>	<i>standard form</i>	<i>logarithm</i>	<i>rather than</i>	<i>number</i>	<i>logarithm</i>
273.1	$2.731 \times 10^2$	2.4364		273.1	2.4364

*as we believed this would better indicate where the 2 came from in the logarithm.*

*We knew this was procedural and to explain how logarithms as indices actually worked, one author suggested we show that just as*

$$\begin{aligned}
 10^3 \times 10^2 &= 10^{3+2} \\
 &= 10^5,
 \end{aligned}$$

*we can show that*

$$3.271 \times 2.893 = 10^{0.5146} \times 10^{0.4614} \text{ (from log tables)}$$

$$\begin{aligned}
&= 10^{0.5146+0.4614} \\
&= 10^{0.9760} \text{ (adding indices)} \\
&= 9.462 \text{ (from antilog tables)}
\end{aligned}$$

*Two of us commented, 'That's great, what made you come up with that?' The author looked at me and said, 'You used one textbook for three years at school, and have taught out of it for two years, have you ever looked at it? This method is from the school's regular textbook.'*

*I realized that I had always used mathematics textbooks as sources of examples and had never read the text for anything else.*

*I still wonder whether we teach students to 'read mathematics', rather than spoon-feed them as I had been spoon-fed. I know that I was never asked to 'read' the subject.*

The completed arithmetic book was published in England. The publishers decided that only 10% of the copies should have answers. We had asked for all to contain them, however a year later they rebound the unsold copies without answers with answers added, and all further reprints included answers. This reflects the different ways that countries regard answers in textbooks. We had wanted students to be able to check their own work, and be able to work backwards if they needed to whereas in England a different view seemed to prevail.

Becoming a textbook author was a positive experience for me. Royalties were significant and contributed to family wellbeing, my father felt somewhat happier about me being a teacher, and my career benefited from invitations to participate in government working parties and to lecture at refresher courses.

Following the success of this first book we produced an introductory text for years 10 and 11 school trigonometry (Nairn, Hall, & Begg 1968). We identified the need for a differently structured book because trigonometry was increasingly being introduced a year earlier than in the past and this implied that the programme needed

to be structured differently. The same philosophy towards teaching and learning is evident in the preface to this book—our thinking had not moved significantly.

These textbooks were the last traditional mathematics books for NZ high schools.

I remember one colleague saying *they are very good, and have probably put back the introduction of new mathematics in conservative schools for another few years*. We considered algebra and geometry textbooks, but with the move to new mathematics and to transformation geometry we felt a little inadequate.

At this time statistics was introduced into applied mathematics. The course designer had recommended a textbook for the subject, but a colleague and I thought it would be worthwhile to co-author a booklet of supplementary statistics examples (Begg, & Thomson 1969). Our local mathematics association agreed to publish it. Our motivation with this set of examples was to provide teachers with further examples for use when introducing year 11 statistics and to supplement the year 12 textbook. In 1969 no one was talking about exploratory data analysis, but the course designer had emphasized an experimental approach to statistics in the course guide. This emphasis was not in the recommended textbook nor in our book that only provided examples. In hindsight the curriculum change that teachers implemented was about content and not about teaching approach; the experimental approach was not supported, indeed the resources (commercial curriculum) and the assessment (assessed curriculum) countered the original curriculum intention.

## 6.2 Joining a different team

My involvement in textbook writing and statistics led to me being invited to join another author group. They had produced textbooks for *new* mathematics for years 9 to 11 involving new approaches to algebra and transformation geometry. Their year-12 book coincided with more statistics being in the curriculum, and since they lacked expertise in that area they asked me to write with them.

We decided to split the planned large textbook into two smaller ones, and in the introductions our thinking was indicated (O'Neill, Laidlaw, Maseyk, Parr, Spence, Begg, & Lee 1972a, 1972b, p. 7). We emphasized the range of ability, the range of purposes for studying mathematics, and explicitly stated that *we expect teachers to change the order or style of presentation, to omit and supplement where necessary.*

The team's way of working was different from what I had been accustomed to. Seven of us were involved and we lived in three different cities. We met twice, to plan the books and to discuss progress. First drafts were distributed, and written comments were sent to us. We were not able to discuss these comments or defend our contribution. Completed second drafts were sent to the senior author who made significant changes to our drafts to ensure that chapters were coherent and consistent. My first reaction when I saw an edited version of a chapter that I had written was shock, but as I looked in detail I could see the improvements.

The two books for year 12, together with the ones for years 9 to 11 that the original group had written sold successfully and the publisher initiated further mathematics



publications. I was involved with three series of student workbooks (O'Neill, Laidlaw, Maseyk, Parr, Spence, & Begg 1973a, 1973b, 1974). These were written for mathematically less-able students in non-examination streams in years 9 to 11. They were designed to be used in any order, and the content had a practical emphasis. The writing involved a planning meeting but individual authors had more responsibility for the workbooks they authored.

I was concerned that publishers were focussing on the needs of more able students with textbooks and the less able with workbooks but not catering for the middle cohort of students who were increasingly shifting to new mathematics. At the same time I felt that the planning discussions had been useful because of the range of backgrounds of the team members, but I had missed the professional development that had occurred through debate about details as had occurred with my first co-authors. While having these thoughts a third publisher approached me.

### **6.3 Taking charge**

My third phase of writing began with this third NZ publisher suggesting that I organize a team to write a series of textbooks for years 9 to 11 students. After discussions with possible co-authors I agreed to the proposal. However, soon after the publisher phoned me, we discussed a problem that had arisen for his firm, and I agreed to withdraw from our agreement, though I said that I might consider continuing the project with another publisher. This was accepted and we parted company. I then discussed the proposition with three publishers to gauge interest. Two responded favourably within a few days—that was my market research. Being

entrepreneurial (and over-confident) I discussed publishing with my proposed co-authors, firmed up agreements with them, and in 1973 set up the part-time sole-trader publishing business, Nexus Books. I hardly knew what I was letting myself in for. One publisher used the industry term *Vanity Press* to describe my venture, but I was not deterred.

I was aware of the advantages of having authors from different regions, but wanted regular meetings so chose colleagues who lived in close proximity. I wanted the team to have had experience in different types of schools and I felt that a woman and a Maori would bring different perspectives. The women who initially joined the team had to withdraw due to other major commitments. I was unable to identify a suitable Maori teacher of mathematics in the city. That left three of us—males of a similar age, good friends who had been through university and teachers college together, and each having taught for about ten years. One lectured at the teachers college and this helped move our focus from mathematics to education.

Our initial project was to produce six books (Begg, Mackintosh, & Thomson 1974a, 1974b, 1975b, 1975c, 1976b, 1976c) to cover years 9 to 11 mathematics. We discussed and came up with a number of underpinning assumptions. These, mainly paraphrased from Begg, Mackintosh, & Thomson (1974a, p. iii), were:

- The approach to algebra was to be within the spirit of the new mathematics emphasizing logic and structure.

- Geometry was to be approached through transformations with informal introductory work and an emphasis on the invariant properties of the transformations rather than on proving all the traditional Euclidean results.
- Statistics was to be taught every year as part of mathematics.
- Optional enrichment examples within chapters, and whole chapters were needed to broaden the knowledge of able students.
- Short chapters (one chapter each week) would be used to allow frequent revision of basic ideas and to avoid the loss of interest experienced by some students when long periods are spent on one topic.
- The use of equipment would be suggested whenever appropriate.
- The use of diagrams, including arrow graphs as used by Papy (1963) would be encouraged to provide alternative representations and to help when language facility was poor.
- The main focus of the three-year course was *relations* which built on primary school work on *sets* and lead to year 12 work on *structure*.
- All material would be classroom tested with unstreamed classes.
- Topics and subtopics would be introduced with discussion rather than exposition and worked examples.

#### ***Incident 6.2—Providing diagrams***

*We assumed that we would encourage the use of diagrams by including many diagrams in all of these textbooks. In many instances these diagrams were drawn on a background grid of squares so that students could copy the diagrams into quad books that had become the accepted mathematics work books in NZ.*

*During classroom testing and later teaching from the textbooks I found the diagrams in the books seemed to make the work easier for students.*

*Reflecting on this some years later I concluded that we went too far. We provided too many diagrams and this encouraged copying rather than strengthening students' visualization skills, I now believe that we should*

*have described more situations in words and asked students to draw a diagram to represent the situation rather than copy what we provided. Further, I wondered if by encouraging the use of squared paper we detracted from the generality of diagrams in geometry and the notion of sketching rather than plotting graphs in algebra. I believe that mathematics be done on loose-leaf paper so that plain, ruled, quad, and graph paper could be used as appropriate.*

While writing these first six books we identified a need for and produced two further textbooks (Begg, Mackintosh, & Thomson 1975a, 1976a) for the local mathematics certificate programmes being developed for less-able year 11 students.

### *Incident 6.3—Local becomes national*

*Although numerous local mathematics certificate programmes had begun with somewhat different course outlines, within a few months of publication of our two books all the local groups had altered their outlines so that the book could be used as the main resource and they would not have to concern themselves with resource production. Soon after this the local certificates merged to become the “New Zealand Mathematics Certificate” and gained more official recognition.*

*While these two textbooks and the local certificates initiative filled a niche, I was uncomfortable with the notion that less-able students could not participate in the mainstream course, in particular because we were writing and testing such a course with unstreamed classes and all the students were coping with the full programme. On the other hand, I knew we were responding to a teacher-driven initiative rather than a government one and I believed that such teacher initiatives should be encouraged.*

*Two years later a student of mine on this course completed most of the two books in less than a month. He had been successful, but he had enrolled for this course because he had been told that he was not good at mathematics.*

*This initiative was successful from a publishing perspective but in hindsight I see it as educationally unwarranted. It reinforced the notion of streaming, and of exclusion from full mathematics programmes. It occurred while other subjects were moving away from streaming and it encouraged mathematics teachers to hold out against this. It allowed teachers to lower their expectations of children (as I had with the above-mentioned student). The course became one that teachers with little understanding of mathematics often taught and that meant that the main mathematical ideas were not always emphasized. It demonstrated to me how commercial curriculum influences practice (the planned curriculum) and the experience of students (the experienced/learnt curriculum).*

As the books for years 9 to 11 neared completion we extended our programme to include two books (Begg, Mackintosh, & Thomson 1977, 1978) for year-12 classes.

Throughout this section (6.3) I have used the term *we* more than *I* to reflect the fact that the three of us worked collaboratively. With each of the three series of books we planned together. We decided on the balance of topics, the focus and order of all chapters (including optional ones), the section headings within chapters, and then, the writing began. We met weekly to discuss drafts and enjoyed the professional interaction. When the drafts were copied for testing they were collated (incident 5.15), and distributed each week to classes for trialling. After trialling I gathered my comments and those from a disappointingly small number of other teachers (perhaps due to the head of department-teacher power relationship, and the fact that teachers are always busy) to provide more feedback to the authors of the final drafts.

Beyond NZ, Fiji (with over 100 high schools) was our biggest market. They had started a mathematics association, had an annual conference, but had little professional support. For five years as publisher I funded the travel for each of our author team then two colleagues to attend their conference as a guest lecturer. This was the beginning of my international networking.

I continued to publish until mid-1983 until I moved from teaching to the government curriculum development division where an obvious conflict of interest arose. At that stage I approached another publisher and they agreed to take over my publishing.

My own teaching (planned curriculum) was influenced by my writing, this meant that the influence was conservative because as publisher I knew that potential sales implied no radical change. The Nexus Books series included discussion, activities and exercises but did not emphasize projects or extended activities, and as I was testing then using these texts my teaching rarely involved significant change. As director at AMC I was aware of the exciting teaching done by teachers of other subjects and from time to time felt that as text authors we did not contribute to such possibilities within mathematics teaching as perhaps we should.

Since 1983 I have continued to be involved with writing, editing teachers guides and journals, and preparing papers and courses for teacher development activities and conferences presentations.

## **6.4 Resourcing teachers**

As a confident mathematics teacher I saw the need for:

- the subject to be organized so that children could move from class to class
- a coherent programme that ensured they progressed in a subject
- students to be able to move to alternative options and streams within a school's overall programmes

I assumed that mathematics was different from other subjects in that students did lots of exercises, did not take notes, and generally did not have to memorise facts by rote. I wondered how subjects managed without textbooks although I had in fact taught science with books used only as teacher resources. I knew that in NZ mathematics

was and is the only subject where virtually every child has a textbook and that other subjects relied on class sets of resource books. I was aware that our situation is different from that in some countries, particularly the USA, where most subjects were textbook based. Textbooks remain a focus for most NZ mathematics teachers and this is reinforced by the publishing industry; one NZ publisher once said to me that publishing of mathematics textbooks was their most stable source of income. This reliance on textbooks made me wonder if a causal connection exists between textbooks and dislike of a subject—mathematics seems to score highly on both.

When considering textbooks and other resources I expected ‘space’ for professional decision-making, but knew that less confident teachers often preferred to be told what to teach and how. I understood the pressure of preparing students for external examinations. In terms of how to teach, I had sought a range of approaches, and I thought that practical activities were useful when introducing some topics, although on reflection I have seen that these practical approaches were sometimes not coherent with the particular algorithm that I was also wanting the students to use.

In NZ in the seventies there was little discussion of multiple methods in mathematics, and this fitted with the structured approach of planning to teach for specific objectives that behaviourism, the prevalent theory of the time, implied. In planning textbooks these specific objectives for lessons were generally organized from a logical analysis of the subject rather than a psychological analysis of how students learn, and this logic was reinforced by the logic of new mathematics, and by the way curriculum, other textbooks, and assessment seemed to be organized.

What our textbooks in the seventies did not encourage (apart from a chapter titled *Project starters* in Begg, Mackintosh & Thomson 1976a), and more recent NZ textbooks still do not, is the extensive use of extended tasks, that is projects, open-ended investigations, extended problem solving activities, and what Ahmed (1987) called *rich learning activities*, instead the emphasis remains on exercises. For me such tasks fit better with newer ideas about learning such as those of constructivism.

If I was writing print resources for school mathematics today I would concentrate on books for teachers with extended tasks and suggestions on teaching approaches. A task for a lesson could be described orally or written on the blackboard. Such books could be supplemented by sets of exercises for students from which teachers could assign work when appropriate. While publishers are conservative technology may challenge the industry and make such a venture viable. Technology already makes *Vanity Press* feasible for aspiring author/publishers and other options with electronic rather than print resources enable teachers to modify resources to suit their needs.

While writing textbooks I became aware of resource problems in the Pacific Islands. I have since seen similar problems in other developing countries. For these countries print resources remain important but teacher texts seem more urgent because of the dearth of teacher education (pre and in-service) and because student texts are unaffordable. However, textbooks written in NZ (or other developed countries) are not suitable without considerable modification. It is inappropriate to use unfamiliar contexts in problems, the first language of learners must be considered, and there are ethnomathematics issues recognized since the 80s that need consideration.



## 6.5 Reflecting on textbook writing

*Working with Mathematics* (Begg, Mackintosh, & Thomson 1975a & 1976a)

demonstrated how textbooks influence curriculum while at the same time curriculum influences textbook writing. To a lesser extent, with other textbooks I have been involved with, I know that authors sometimes chose to emphasize or ignore a topic, and while not changing the official curriculum they influenced the implemented one.

Textbook writing was significant within my professional development. It involved researching alternative tasks and approaches, reflecting on my own practice, and considering the role of assessment in learning, in-school testing, and external examinations. These interrelated activities influenced my thinking which later led to the model for educational development I discussed first in 2001 (Begg 2001c) and discuss further in 10.2.

I became aware of the authority of resources when students in class would not amend an incorrect answer in a the textbook because *the textbook must be right*, even when as their teacher and the author I assured them that the answer was incorrect. This authority is also evident when teachers want simply to follow a textbook rather than plan for themselves, think through the issues, consider their situation, and regard the textbook as a resource. I can understand that initially following a textbook helps a teacher discover what the text offers and ignores, but I assume every text needs to be customized to suit situations.

As a textbook author using my own textbooks I saw curriculum as an action-reflection cycle process with:

- writing being influenced by past experience and reading
- moving from draft to final edition being influenced by trialling the draft and assessing it's effectiveness
- making further changes in subsequent years to how these texts were used

I originally thought that this cycle ended when I had made changes. But in fact I have never been satisfied, there are always more changes to consider, and sensibly the resources (commercial curriculum) need to be replaced not only for a new official curriculum but also when the desired changes require a different approach.

With thirty years hindsight, the assumptions made throughout my writing have become very clear. These include:

- An emphasis on the subject mathematics rather than on how students learn
- A focus on specific learning objectives and activities leading to these rather than opening up opportunities for explorations in other directions
- Low expectations of students, especially the so-called 'less mathematically able' (hence the *unit* series (O'Neill, Laidlaw, Maseyk, Parr, Spence, & Begg 1973a, 1973b, and 1974) and the *working* series (Begg, Mackintosh, & Thomson 1975a & 1976a)
- Virtually no effort to help teachers find what students already knew, what their interests were, or what contexts might be appropriate
- No consideration of the aims of education in general

Other assumptions, made without thinking, although appropriate at the time, are thirty years later not so. These include:

- Not using technology
- Little emphasis on mathematical processes (problem solving, reasoning, communication, and making connections)
- No consideration of cultural implications within the classroom (e.g., not questioning the teacher, and limited language facility)
- No focus on mathematical thinking (generalising and specialising, conjecturing and verifying, visualization, ... )

It is interesting to read what Whitehead (1932, p. 7) wrote about textbooks.

Whenever a text-book is written of real educational worth, you may be quite certain that some reviewer will say that it will be difficult to teach from it. Of course it will be difficult to teach from it. If it were easy, the book ought to be burned; for it cannot be educational. In education, as elsewhere, the broad primrose path leads to a nasty place. This evil path is represented by a book or a set of lectures which will practically enable the student to learn by heart all the questions likely to be asked at the next external examination. ... theoretical ideas should always find important applications within the pupil's curriculum. This is not an easy doctrine to apply, but a very hard one. It contains within itself the problem of keeping knowledge alive, of preventing it from becoming inert, which is the central problem of all education.

I agree with Whitehead, teachers may find it difficult because it moves beyond their established comfort zone. However, from the learners' perspective I think Vygotsky's (1978) notion of the *zone of proximal development* is more relevant—while a textbook may seem difficult it should be *just* ahead of the learners' development and will therefore not be too difficult. Whitehead's comment does raise the question for me, are we trying to make learning too easy and trivialising what is done in school?



Chapter 7 Developing curriculum

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7.1 Changing roles

Phase four of my life began when I joined the Curriculum Development Division (CDD) of the NZ Government’s Department of Education (DoE) in 1983. This phase lasted until 1989 when a restructuring of government departments led to the replacement of the DoE with a new Ministry of Education (MoE). The phase is summarised in table 7a.

Table 7a: Time-line for career in CDD.

1983	Education Officer (EdO) in the CDD of the
1984	NZ Government’s DoE (with responsibility
1985	for high school mathematics)
1986	
1987	
1988	Acting Senior EdO, with more general responsibility
1989	Member of restructuring committee—Department closed.

My responsibility within the CDD was for high school mathematics (years 9–13) with some overlap with my primary colleague in years 7 & 8 to ensure a smooth transition into high schools. The main differences in our work was that for years 1–8 the DoE provided primary schools with the curriculum, textbooks and resources

while for years 9–13 the focus was on curriculum, external examination prescriptions, and teacher guides, with schools having funding to purchase textbooks. Although I had ceased writing and publishing textbooks I continued working on draft curriculum documents, teachers guides (see 7.2), and newsletters for teachers.

I was familiar with how the DoE worked, having been involved in numerous working parties, and having been seconded from AMC for a term in 1982 as a mathematics advisor in a Regional Office of the DoE. The DoE's head office, the regional offices and the CDD were hierarchical; this was typical of government departments but also reflected school structures which was understandable as many of the staff had been teachers.

There was no formal induction into CDD. I was fortunate in sharing an office with an experienced colleague and she introduced me to the working definition *curriculum is all planned activity for the classroom*. My predecessor with responsibility for high school mathematics remained at the CDD in a senior role and his predecessor was in the DoE's research division, so institutional memory in terms of mathematics was readily available. Everyone in CDD was willing to talk about their work so I organised my own induction and talked to many of them.

Diverse approaches were being used; most being variations on the research-development-dissemination (RDD) model that underpinned the CDD's work. This model involved some participation by teachers and feedback loops to CDD officers, though for most teachers it was still a top-down process.

Most curriculum projects were initiated because of teacher pressure; the research input started with the curriculum officer finding what teachers wanted, and information about overseas developments. Later the DoE's research division assisted with feedback from teachers on curriculum drafts. There were exceptions to this, research for reading had been extensive over about 20 years and science education research had also been significant. In mathematics the extra component was from the second and third international mathematics and science studies (SIMSS, TIMSS).

Dissemination included refresher courses, teacher guides and associated teacher and learner resource material. Curriculum officers provided the content for such resources while the editing and production was organized by the resource development division of the DoE.

One curriculum officer worked in an evolutionary way rather than in the RDD manner. He kept the social studies curriculum in draft form for nearly ten years and encouraged teachers to experiment, make changes, and try new ideas. This resonated with my anarchic way of working, but NZ had national examinations in the last years of schooling so the mathematics curriculum needed to be officially gazetted.

Three assumptions that seemed implicit were that:

- development projects were generally driven by policy from the top
- curricula were developed by teams of about 20 people, mainly teachers
- other teachers were more involved in the dissemination stage

Such an approach was an improvement on practice before CDD was established when groups of inspectors wrote curricula with minimal teacher input.

I was disappointed that virtually nobody spoke about theories or beliefs underpinning what they were doing, the exception being those who I remember saying, *you have to start where the teachers are*. I had been asked about constructivism in my initial interview, having only heard the word but not known its meaning I had fudged. Hardly anyone that I spoke to knew about it, however, a few months later a new science curriculum officer joined the staff, I got to know her well, and as she had worked with Roger Osborne at Waikato on the learning in science project (LISP) (Biddulph & Osborne 1984; Osborne & Freyberg 1985) which was based on constructivism and also with Ros Driver at Leeds, I soon found out much more. This shifted my thinking on curriculum towards learning theory rather than my initial teaching practice perspective and stimulated an ongoing interest in learning theory.

In 1974 the Educational Development Conference (EDC) made recommendations about curriculum (Holmes 1974), these included:

... more decisions on what is to be learnt and taught, and on methods of organising learning, should be taken by the schools themselves. Staff and parents must participate in the decisions, and so must pupils, with their participation growing as they mature. The principal must remain a key figure in creating an atmosphere in which constructive innovation can take place. He should become the leader of a team, however, rather than a figure of authority. (Holmes 1974 p 24, 2.12)

National curriculum guidelines need to be stated in such a way that they:

- delineate the extent and depth of the areas of study;
  - suggest appropriate classroom practices;
  - ensure that each pupil receives a balanced education;
  - ensure that parochial pressures do not limit or distort programmes;
  - provide a framework for a broad general education and opportunity to specialise;
  - ensure that student progress is monitored at all levels;
  - allow for variety of curriculum organisation in broad fields of knowledge, as well as subject areas;
  - direct attention to the buildings, staffing, finance and resources which are necessary for each curriculum choice;
  - ensure that freedom within the guidelines is real and not illusory.
- (Holmes 1974 p 25–26, 2.16)



While some of us in CDD felt these should be adopted, and worked towards them when we could, the recommendations never became government policy. In 1986 I was preparing draft guidelines for high schools reviewing their curriculum which was intended to give suggestions and ways forward without being prescriptive. These guidelines were based on the assumption *that curriculum development should be bottom-up rather than top-down* (Dept of Education 1986, p. C1) and recognized the role of schools in interpreting national curriculum for particular situations which fitted with the recommendation from the EDC (Holmes 1974). This draft was fairly widely distributed and perhaps influenced thinking but was not finally published.

A highlight in 1984 was attending the International Congress on Mathematics Education (ICME-5) in Adelaide and a small pre-ICME meeting on curriculum organized by Victorian colleagues. This extended my international networking. I made valuable contacts in Australia and with colleagues from elsewhere, I began to appreciate the international influences on curriculum and these two meetings started my overseas conference ‘addiction’ which has led to me jokingly being referred to as a ‘conference junkie’.

## **7.2 Writing teacher guides**

In my first years in the CDD we were completing the Form 1–4 (years 7–10) curriculum (Department of Education, 1987). Before this was printed, my task was to bring together groups of teachers to prepare two teacher guides (Department of Education 1986a & 1986b). In addition the University Entrance Board was changing the year 13 bursary and scholarship prescriptions for mathematics by replacing pure and applied mathematics with *mathematics with statistics* and *mathematics with*

*calculus*, and I was responsible for producing teacher guides for these (Department of Education 1986c, 1986d, 1988a, & 1998b). Both these courses included components of applied mathematics; but *mathematics with statistics* also included a 20% internally assessed practical component which threatened numerous teachers.

The teacher guides I was concerned with for the F1–4 curriculum were an *Introduction* (Department of Education 1986a) and a guide that provided suggestions on how to implement the curriculum in forms 3 and 4. The first was produced quickly and I organized four one-week meetings with different teachers to produce the second.

#### *Incident 7.1—Ideas*

*Meetings one and two went well. Half the teacher guide was in draft form. At meeting three more material was being prepared, then one teacher said, “We all know how to teach this, we don’t need this guide, we need something different.” We stopped and discussed what ‘something different’ might be.*

*We decided on an ‘Ideas’ resource that would link topics of the curriculum with non-textbook activities—investigations, projects, problem solving activities, games, puzzles, writing topics, group activities, and tasks related to other subjects. The group started on this guide that was later referred to as, Ideas’ (Department of Education 1986b). I drafted a letter for the first two working party members to explain what was happening,*

*The responses to my letter were encouraging. I organized two more working parties and involved creative teachers, teachers from rural areas, and teachers of other subjects who taught one class of mathematics.*

*This teacher guide seemed worthwhile. However, I wondered about the value of teacher guides sent to schools. A year later, at an in-service course I used activities from this guide. At the end of my session a teacher said that the day had been worthwhile because they had learnt many unfamiliar teaching ideas. They were somewhat flabbergasted when I held up my copy of ‘Ideas’ and told them that CDD had sent each high school one for every mathematics teacher.*

*“We need something different” was important. It showed me that teachers know what they want and need, and how a CDD officer’s job was to facilitate (which I thought was my way of working after AMC). It also reminded me that these teachers had colleagues for whom the textbook was the curriculum.*

To supplement *Ideas* and to help teachers become less dependent on textbooks I produced and distributed copy-masters (Department of Education 1986f), discussion starters (Department of Education 1986g), and five mathematical picture packs (Department of Education/Ministry of Education 1987–1991). In addition I organized the production of two videos for mathematics classrooms, and edited a newsletter for teachers of years 7 to 13 (Department of Education 1985–1989).

The teacher guide for the Form 7 (year 13) course *mathematics with statistics* (Department of Education 1986c) was similar to previous guides, the main new material concerned the new project component. Teachers soon asked for more support material and further working parties were held to provide this (Department of Education 1988a) together with ideas for assessment at all levels (years 9 to 13) including assessment of projects (Department of Education 1988b). I saw this project work as very worthwhile; it ranged between practical work, experiments, a series of mini projects, and one large project. It was assessed in the school as 20% of the final course mark, and teachers were expected to provide 20% of class time for it. The curriculum committee believed that it was important and had discussed whether such a component should also be in *mathematics with calculus*, but they decided to try it first in one subject. Teachers were concerned about moderation and the decision was made that the 20% internally assessed marks for projects for each school should be scaled, using the 80% externally assessed examination mark.

#### *Incident 7.2—Assessment and practical work*

*In the three years after the project component was introduced many teachers remarked on its value, how good the learning was, and how they had introduced projects into other mathematics courses because of the value of projects and to help prepare students for the project in year 13. However, I was disappointed by what*

*occurred with a number of teachers in one region. They decided that to maximise marks for their students they would use all class time for teaching the other 80%, and that the practical/project work would not be demanding and would be marked leniently. They assumed that their students would do well in the examination and the internally-assessed mark would then be scaled up.*

*When asked about this they said that parents wanted their students to get the highest marks possible, and that was what they were doing. I could see their point of view, I also believed that teachers should make decisions, but I was unhappy and wondered if a more robust moderation process rather than the cheap alternative should have been set up.*

*This issue was important for me, it was further evidence of assessment influencing curriculum. Teachers were using projects and would not have been if the work had not been assessed; on the other hand, others were using the system for high marks (though perhaps for less learning).*

*Now, 15 years later, I find it difficult to justify any high-stakes assessment, but see little chance for change in the present climate of competition and accountability.*

### **7.3 Influencing curriculum**

I believe I worked in a facilitative manner but was aware that my input was very significant. Consequently it is interesting to think about the influences that were impacting on and changing my views of curriculum. My prior experiences as a learner, teacher and textbook author helped form the foundation of my views. My experiences introducing new mathematics had made me think more widely about the mathematics curriculum. In CDD I had seen how reading and science were shaped by local research. And, I noted how four international influences impacted: the Cockcroft report (Cockcroft 1982), the *standards* (NCTM 1989), international comparisons (SIMSS, TIMSS, & PISA), and technology (calculators/computers).

#### ***Cockcroft***

The Cockcroft report (Cockcroft 1982) was an important focus at ICMI in Adelaide in 1984. I had read the report before the conference and it had resonated with me. It

seemed that it could have been a local report. I found that it also resonated with Australian colleagues. The paragraphs that especially struck a chord with me were 243 (& the associated 244–253), and 342 (& 343–344). Paragraph 243 neatly summarised my thinking about the need for more varied teaching, while 342 expressed very strongly what had not been put into words.

243 Mathematics teaching at all levels should include opportunities for

- exposition by the teacher;
- discussion between teacher and pupils and between pupils themselves;
- appropriate practical work;
- consolidation and practice of fundamental skills and routines;
- problem solving, including the application of mathematics to everyday situations;
- investigational work. ...

342 It therefore seems that there is a 'seven year difference' in achieving an understanding of place value which is sufficient to write down the number which is 1 more than 6399. ...

Paragraph 243 reinforced my belief about the need for more than a textbook orientation to the subject. And 342 led me to reconsider how high school streaming and setting procedures across subjects were not achieving what was hoped for and that teachers might be better to think of all classes as unstreamed. My reaction to 342 was: if a seven-year difference exists, and if good teaching occurs, then the gap will be widened not narrowed; alternatively, if we concentrate on the non-achieving students, will we be penalising the high-achieving ones.

I reprinted and distributed the introduction to the Cockcroft report that had been prepared for an ICME 5 Action Group. This stimulated more discussion. In addition to considering 243 and 342, the emphasis on mental calculations and estimation raised awareness of the importance of teaching these skills (especially at primary-school), and the debate about calculator and computer use resonated in NZ.

Cockcroft's comments on the purposes of assessment fitted with my views, but their section on examinations seemed like accepting the inevitable, however I appreciated their two principles related to examinations (in 521):

The first is that the examination papers and other methods of assessment which are used should be such that they enable candidates to demonstrate what they do know rather than what they do not know. The second is that the examinations should not undermine the confidence of those who attempt them.

My main point of difference with the Cockcroft recommendations, though not a difference for most NZ teachers, was the notion of a foundation list (paragraph 458) built on the assumption that *lower-attaining pupils* could not cope with normal programmes. For me this underrated the power of learners to learn and legitimated teachers having lower expectations of some learners. In spite of my concern, others agreed with the notion, and an agreement on the need for courses for low-attaining students became one basis of our work in 1987–89 on the curriculum for years 11–13 which resulted in the draft (Department of Education 1989), see 7.5.

### ***NCTM standards***

In NZ I had taught old and new mathematics. I realized that logic and reasoning had been emphasized with traditional Euclidean geometry, and while this had been reduced when transformation geometry was introduced, logic had been given more emphasis with the *new* algebra. Problem solving too had always been part of school mathematics, though often only in the form of word problems that were applications of ideas just learnt or taught; it was in examinations that students had to consider what ideas underpinned problems. The ideas of Pólya (1957) had been discussed at courses, but had not been integrated into the official view of school mathematics.

I had read the “Curriculum and Evaluation Standards for School Mathematics” (NCTM 1989). What delighted me was the way the standards listed *mathematics as problem solving, mathematics as communication, mathematics as reasoning, and mathematical connections*, alongside content. This listing legitimated a broader view of school mathematics than had prevailed. I wrote about these as the process strand that complemented the content strand, and spoke of them as the doing and knowing strands. I saw these strands as orthogonal rather than parallel, (as integrated, not separate) which made structuring curriculum more difficult, and I recognized a probable need for teachers to consider the processes separately before integrating them with content.

The process strands caused an important change in the way that the curriculum committee thought about and structured our work in 1987–89 on the draft curriculum for forms 5–7 (year 11–13) (Department of Education 1989), see 7.5. In addition, it was an important input into the next round of curriculum review (Ministry of Education 1992) that I was only peripherally involved with, see 8.7.

### ***International comparisons***

The DoE had participated in the Second and Third International Mathematics and Science Studies (SIMSS and TIMSS) that compared countries’ performances (and later participated in the PISA study). I had reservations about this. I thought that regardless of how we performed in international comparisons, we would always want to improve, and the money should be used for mathematics education within NZ. It seemed to me that international comparisons tell us nothing of value when they report that we do better with statistics which we spend much more time on, and less

well with reasoning in Euclidean geometry when our approach to geometry is not the traditional one. In addition, international studies hide variation such as that between privileged and other schools that may be more relevant in NZ. I knew that NZ had not done well in TIMSS, and in spite of CDD asking for more initiatives none had been approved. Looking back I see NZ's involvement in these studies as political, and having little influence in terms of change. I saw participation in such studies as possibly leading to a globalized or international curriculum and this concerned me as I believe that diversity leads to variation and desirable growth and should be celebrated (see 9.5).

### ***Technology***

As a teacher I had introduced and encouraged computing in all four schools I worked in. I had provided calculators in all but the first school, and in the fourth school the students often brought their own calculators to class. However, I had been discouraged sometimes by the attitude of others, for example, as in the next incident.

*Incident 7.3—Show all your working.*

*I was at a markers meeting for our year 10 external examination. The question was something like:  $\frac{1}{2} + \frac{1}{3} = ?$  (Show all your working)*

*One student had written*

$$\frac{1}{2} + \frac{1}{3} = \boxed{(}\boxed{1}\boxed{\div}\boxed{2}\boxed{)}\boxed{+}\boxed{(}\boxed{1}\boxed{\div}\boxed{3}\boxed{)} \\ = 0.833\ 333 \dots$$

*I had marked this correct. The examiner insisted it was wrong because the answer should be a fraction. I claimed the answer was a fraction, a decimal fraction.*

*For me the student had demonstrated that he clearly understood what fractions meant, order of operations, recurring decimals, and how to use a calculator (which was allowed for all parts of the examination). I felt that this student was unfairly penalised, and saw this incident as typical of the initial ambivalence to calculators that numerous colleagues had.*



In my experience technology implied that some tasks were more easily completed, and others could not have been considered without such tools. I reflected on my use of manual calculators in statistics in 1960 and logarithms and slide rules in the 1950s at high school. I assumed that electronic calculators and computers were the modern equivalent of these and were inevitably going to become part of school mathematics. The research that most impacted on me about calculators was Hilary Shuard's project (PrIME Project 1987, 1989, & CAN Newsletters) where she talked about:

- not teaching the four operations
- students learning all four operations with calculators
- students not relying on calculators but developing other strategies
- calculators as a way 'into' maths, not as a way 'out' of it

I saw *using technology* either as *making connections (with technology)*, or as a new process, *using tools*. I saw technology as supplementing other ways of working. However, I was concerned with the possibility that it might lead to a procedural approach to mathematics without developing understanding. I also believed that the IT industry pushed technology as a money maker for themselves and suspected that much of the research on technology was done by technology converts rather than (so-called) neutral researchers.

### ***Overseas and local influences***

Cockcroft, NCTM standards, international comparative studies, and technology use were influences from overseas and were part of the long-term trend of small countries (especially former colonies) following their ex-colonial masters. Working locally I had seen curriculum being influenced by textbooks (6.3), assessment (7.2),

teacher development (with the new mathematics), and teacher experimentation (informal research, 5.2 and 5.5). I was also aware that policy decisions such as those that influenced assessment and equipment grants impact on curriculum.

## **7.4 Finding local influences**

Five influences impacted on my thinking and work on curriculum during the 80s in NZ, these were feminism, ethnomathematics, Maori education, Pacific Island education, and integrated education.

### ***Feminism***

While I was teaching a number of female colleagues had joined NZ feminist teachers groups, others had formed an EQUALS group (linked with the Californian group) for mathematics and science teachers, and some were members of the International Organization for Women in Mathematics Education (IOWME). At the same time the traditional male dominance within high school teacher unions was rapidly disappearing. Everything these women said made sense, yet as a textbook writer I had tried to ensure that contexts were female-friendly and as a teacher I had not known what to do. In CDD an officer was appointed with responsibility for women's education, and this, together with other women in the division having feminist leanings made me start thinking and reading more about feminist thinking. The book by Gilligan (1982) and then one by Belenky, Clinchy, Goldberger, & Tarule (1986) caused me to reflect and rethink.

*Incident 7.4—Reading “Women’s ways of knowing”*

*Reading this book I realized I had not considered being ‘silenced’, though I knew that girls were often quiet in my classrooms. Similarly I had not really thought about ‘listening to the voices of others’, in class I listened for correct responses. ‘Accepting without question what an authority might say’ was what I knew some students did.*

*More disturbing were their chapters on ‘subjective knowledge’. Intellectually I acknowledged the inner voice of instinct and intuition, but I had not listened for it; and I had thought about the ‘quest for self’ in terms of spiritual growth, rather than as listening and watching inwards.*

*In terms of ‘procedural knowledge’, the voice of reason was thinking for me, but the notions of separate and connected knowledge were quite new to me.*

*Constructed knowledge resonated with my new ideas of constructivism and seemed to me to be how one copes with alternative views.*

*Regarding teaching mathematics, I wondered: When is it appropriate to use instinct and intuition? How can I as a teacher ensure that students are not silenced, and that they engage with ideas rather than merely accepting them? I wondered what I might do but found no easy answers. The notion of teaching by questioning and by stimulating discussion rather than by telling seemed to go some way to ensuring that people think rather than accept, but, many students say ‘just tell us what we have to know’.*

*Much later I realized that ‘hermeneutic listening’ (Davis 1996) and ‘noticing’ (Mason 2002a) included looking and listening inwards as well as outwards. But while I realized this, it was still not part of my practice.*

*Even now, I know that most of my thinking relates to (logical) reasoning, and while I can get by in teaching situations, that is not adequate for successful personal relationships or for developing a self/spiritual awareness. While this is of personal concern, I do wonder what should be done in education?*

The feminist movement brought many injustices to the fore and had a considerable influence on NZ society, but the issue of different (including women’s) ways of knowing is of fundamental importance and is still not adequately addressed.

While in CDD I organized many working groups and tried to increase the participation of women. The procedure for selecting most people for working groups was to ask inspectors to nominate people. Mathematics inspectors, mainly men in the 1980s, generally nominated middle-aged males who taught in city schools. I have previously written about my attempts to change this, (Begg, 1996, p 62):

To try to improve this imbalance I sent out a nominee form to inspectors asking them for the names of four people from whom I would select two. I asked for a city male, a city female, a rural male and a rural female. The first time this went out to the regions two inspectors still nominated only men. I accepted one man from their regions and one man and two women from the other two regions. It only happened once.

As a result of the improved gender balance on working groups, the work was done (or seemed to be done) faster, the breadth of ideas increased, and the concerns and the contexts were different. The groups seemed more willing to entertain alternative suggestions, and I believe that the women added another dimension to our work.

### ***Ethnomathematics***

At ICMI 5 in Adelaide D'Ambrosio (1984) discussed the socio-cultural bases for mathematical education and I heard the word ethnomathematics for the first time. I came to see ethnomathematics as relating to the cultures of women, Maori, Pacific Islanders, and other marginalised groups. Ethnomathematics raised my awareness of other ways of knowing, thinking, and working; and as women, Maori, and Pacific Islanders were part of our schools it seemed important that these be considered in curriculum deliberations. In the years that followed I attended conferences about ethnomathematics and wrote papers, the most significant being with colleagues (Begg, Bakalevu, Edwards, Koloto, & Sharma 1996). We discussed the situation in Oceania and showed with examples how culture impacts on mathematics and education. More recently I have wondered (Begg 2006a) if we need to emphasize ethno-education rather than ethnomathematics.

### ***Maori education***

In CDD one officer had responsibility for Maori education. He organized for the CDD to visit his *marae* (tribal/home meeting ground) at Whangara for a three-day *hui* (meeting) about Maori education. At this meeting we discussed how each subject might contribute to the education of Maori pupils to improve their achievement level. We talked about traditional learning, the Maori spiritual dimension of learning and

the desire to retain traditional Maori knowledge as well as achieve well in a *pakeha* (white people's) society. I was excited by the possibilities and saw this as related to ethnomathematics.

On returning to head office I sought approval and seconded a mathematics teacher who, although he was a non-Maori, was reasonably fluent in *te reo* (Maori language) and he worked with me for two years. He worked fairly independently, I gave what assistance I could, and found funds for his activities. At that time some bilingual schools (or sections of schools) existed, while others schools taught mainly in Maori but mathematics was taught in English. His main four projects were:

- organizing meetings for high-school teachers of mathematics to identify what was needed for students studying mathematics in Maori
- preparing and sharing resources for Maori students when the teaching was in English by producing the occasional publication, *Te Kupenga* (The Net)
- preparing and sharing resources for Maori students when teaching was in *te reo* (the Maori language) with another occasional publication, *Nga Mauranga* (The Catch)
- working with the Maori Language Commission to ensure that Maori translations were available for the school mathematics vocabulary

The highlight of this venture occurred at a hui, when, after two years of exploring possibilities the Maori teachers told the seconded teacher and I that we were no longer needed. They had developed a vision of what was possible and the confidence to do it. These Maori teachers had input into the draft form 5–7 (years 11–13) curriculum (Department of Education 1989) that I was preparing, and into the next

round of curriculum reform in 1993 when many were involved in the development of the Maori mathematics curriculum, *Pangarau*, (Ministry of Education 1994).

Working with this seconded teacher and with Maori teachers I became aware that mathematics was not a *subject* in traditional Maori knowledge, that mathematical ideas and thinking were embedded in other spheres of knowledge, and that Maori people had other ways of working and thinking—in particular, they were an oral rather than a written culture, they preferred working communally rather than individualistically, they learnt by observing more than by questioning, and their culture led them to respect elders (such as teachers).

Working with the language commission involved starting with concept maps with the 600 words we found were used in school mathematics. Some words were synonyms and only one Maori word was needed for them, while some did not need a specific term (e.g., a pentagon could be a five-sided polygon). The language commission worked with a number of principles, these included:

- transliterations from English were not to be used except in cases where words were already embedded into the language
- if possible, each word was to be descriptive
- completely new words could be invented
- old Maori words with related meanings which were no longer used could be redefined
- the new term had to sound right in typical sentences
- these words were provisional; time was needed to gauge their acceptance.

A good example of a new word is the one chosen to describe (school) mathematics, *Pangarau*. *Panga* is an old term for a (*philosophical*) *connection* and *rau* means *one hundred* but is also used to mean *many*. Thus mathematics was defined as the study of ‘many connections or relationships’.

Our role was to identify terms, explain in non-technical terms what they meant, and provide numerous sentences in which they might be used. (It later emerged that this presented some problems as mathematical language is usually in the *active* voice, while much of Maori language is *passive*.)

This initiative with a Maori mathematics vocabulary was part of the language commission’s work to ensure that the language was evolving, could be used in a modern technological world, and would not die (as it had appeared to be doing). From my perspective the importance of language was not merely for the sake of mathematics, it was for the preservation of culture. I felt privileged to participate in this project, albeit in a minor role, and my participation led me to consider the challenge for Pacific Island languages.

### ***Pacific Island education***

Before joining CDD I had visited numerous Pacific Islands and was aware of the comparative shortage of resources for education. I knew that a number of these nations followed the NZ curricula, and used NZ textbooks. While in CDD I assisted in an aid project in Vanuatu that aimed at developing local curricula rather than maintaining the parallel English and French systems.

My involvement in the Maori-mathematics language initiative led me to consider establishing (and maintaining) a Polynesian-mathematics vocabulary data-base. I knew that the oral Polynesian languages had been written by different groups of missionaries using different alphabets and though words no longer looked the same, many commonalities existed. I thought that the Maori language commission's work might provide help to other groups.

Working with the DoE's international division that included NZ's UNESCO office in 1988, I successfully applied for a UNESCO grant to run a conference *Mathematika Pasefika* bringing people from the Polynesian triangle together to begin work on the proposed data-base. Because of the long-term planning involved with such grants, and the restructuring of the DoE into a MoE, the conference was held in 1991 after I had left CDD and was teaching at the University of Waikato. We were not able to get participants from all Polynesian nations but had participants from the Cook Islands, Fiji, French Polynesia, Niue, Tokelau, Tonga, and Samoa. We supplemented these with Islanders from these nations who were teaching in NZ, and some of us who had been involved with the Maori language work. The conference involved preparing a pre-conference work book (Begg 1991), the database (Begg 1992a), and the conference proceedings (Begg 1992b). The meeting was valuable in terms of the database, general discussions about mathematics education in the Pacific, and networking. Two incidents stand out.

*Incident 7.5—Learning other languages*

*One NZ Maori teacher at the conference was a fluent Maori speaker though he had been brought up speaking English and French. He had a good ear for languages and listened carefully to the small groups talking in their own languages. He soon joined*



*in with a number of them. After a few days overseas delegates from three countries said to me, "He couldn't speak my language at the start of this conference."*

*It was true, he had not been able to speak these other languages, I discussed it with him. He told me that while the alphabets were different, most of the words were similar, so one only had to notice the differences and then it was easy.*

*These similarities were made obvious to me as we put together the data-base. For example, the word for six was 'ono' in NZ Maori, Cook Islands, Fiji, Hawaii, Niue, Samoa, Tahiti, Tokelau and Tonga, while the words for seven in the same nine languages were: whitu, itu, vitu, hitu (2) and fitu (4).*

*I found the Island nations were more willing than NZ Maori to use transliterations as they saw no risk of their languages disappearing, and they were concerned about making it easier for students to move from learning in their mother tongue to learning in English some years later.*

*I wondered, and still wonder about the way that our work in NZ has caused more divergence of NZ Maori language from what might be thought of as the proto-Polynesian language.*

*(Work on the data-base continued after the conference with dictionary searches and with graduate students from the islands who are concerned with problems of teaching in their native languages.)*

#### *Incident 7.6—Mixed meanings*

*As part of the data-base project we had a number of words for equivalence relationships, in particular the words equal, equivalent (sets and sentences), identical, congruent, and similar. In at least one Pacific nation the same word was used for all of these, while in other nations one word was used for some of them.*

*I was concerned about the problems this would cause in answering questions in class and in examinations, and in moving later to learn in English. They saw the problem arising because the teachers did not appreciate the different meanings of these terms.*

*Reflecting after the conference I thought, 'I knew language was important, now I have more idea how important it is, but, there are many challenges in the islands apart from language.'*

After Matematika Pasefika I successfully applied for a further grant, for the conference Curricula Pasefika (held in 1997). I organized this conference but was unable to attend it. Since 1991 my interest in mathematics in Oceania has continued, mainly through working with international graduate students from the island nations.

### ***Integrated education***

While in CDD I was on an advisory committee for a research team working with a high school that was attempting to integrate subjects in their school curriculum. This project proceeded successfully with all subjects apart from mathematics. Notions of the uniqueness of the subject, the amount of procedural material that needed to be taught before contextual work could be done, and the need for streaming were three of the concerns that were barriers for the proposed integration from the perspective of the mathematics teachers.

This experience with these successful but conservative mathematics teachers helped me appreciate the barriers to change that exist with some high school teachers who focus more on mathematical content than on students.

### ***Influences***

My involvement with feminism, ethnomathematics, Maori education, Pacific Island education, and integrated education raised issues concerning: different forms of knowledge and ways of knowing, the impact of language on knowing, and different views about the purpose of education. These ideas sat comfortably with my constructivist ideas; they reminded me that people are always involved in change and that we all construct our own realities and do not see things the same way.

In terms of the big picture I saw that mathematics could be viewed as a tool of western and male colonisation that caused other cultures to bend to the dominant western imperialism rather than celebrating diversity. Considering marginal groups I saw parallels between the ways that girls, Maori, other indigenous people, and

immigrants were sometimes treated when underperforming (by western male criteria): first blame the girls, then blame the syllabus and the teachers, later blame mathematics, and finally see the situation as challenging to the educational system.

## 7.5 Working anarchically

The DoE had standard ways of doing things, however, they were more concerned with outcomes than methods and gave us considerable freedom in how we achieved these. I felt strongly that democratic ways of working and bottom-up rather than top-down decision-making with input from teachers was desirable. I had benefited from considerable teacher input in the teacher guides I had been preparing and hoped in future projects to ensure that teachers had both input and choice.

The major project I was to lead in CDD started in late 1986. It involved preparing a Forms 5 to 7 (years 11 to 13) mathematics syllabus and supporting teacher guides. At that time the curriculum for years 1 to 6 had been written, and I had been involved with the years 7 to 10 document (Department of Education 1987) that was soon to be published. There had never been a formal curriculum for years 11 to 13, instead the work in these years depended largely on examination prescriptions, see table 7b.

Table 7b, *Senior-school qualifications*

Class/Year	Qualification	Audience	Assessment
Form 5 (Year 11)	School Certificate	Most students	Examination
	New Zealand Certificate	Low attainers	Examination
Form 6 (Year 12)	University Entrance	Most students	Examination (& accrediting)
	Sixth Form Certificate	All, (especially low attainers)	Internal assessment (school-based courses)
Form 7 (Year 13)	University Scholarship	Top students	Examination
	University Bursary	Able students	Examination
	Higher School Certificate	All students	Internal assessment

For year 11 the *New Zealand Mathematics Certificate* had started off as teacher-initiated *Local Mathematics Certificates* (see incident 6.3) for the lower 40% of the cohort because School Certificate worked on a 50% pass/fail, these students were not achieving success, and the course was considered too academic. Students were not able to enter for both School Certificate and NZ Certificate in the same year. At sixth form most students sat *University Entrance* and entered *Sixth Form Certificate* but numerous schools also offered alternative courses for low attainers. Similarly, top seventh form students sat *Scholarship* and *Bursary* and were awarded *Higher School Certificate*, others omitted Scholarship, and some low attainers only entered Higher School Certificate, though again, some schools offered alternative courses for them. Scholarship and bursary students could enter in either or both of two mathematics subjects—*mathematics with calculus* and *mathematics with statistics*. In addition, students were increasingly doing multi-level study, for example they might sit some subjects at form six level and others at form five level.

A board controlled by the universities administered the entrance, bursary and scholarship examinations; this was independent of the DoE although they had representatives on it. School Certificate was administered by a DoE organized School Certificate Board. Both these boards had subject committees. The New Zealand Mathematics Certificate was administered by the New Zealand Association of Mathematics Teachers (NZAMT). Alternative courses for Sixth Form Certificate were developed by schools and approved by mathematics inspectors, although increasingly some units of work for these courses were being organized by NZAMT.

When this curriculum committee began there were no plans to change the emphasis or nature of the school qualifications. The curriculum was to provide coherence, continuity, and structure to the range of courses, and to link with earlier curricula.

I came to the project with additional concerns:

- Some schools were seeking approval for Maori language mathematics courses for these qualifications
- An increased emphasis on the mathematical processes was desirable (Although processes should ideally be integrated with content, I thought that there was an initial need to have a process-focussed course until teachers became more familiar with them)
- Flexibility was desirable with implementation so that schools could experiment and make changes as and when they saw fit (as they could with the introduction of new mathematics twenty years earlier). However, I knew that some teachers preferred a well-defined curriculum to flexibility.
- The RDD model seemed inappropriate—it did not involve enough people in the research or the development stage, and I envisaged research, curriculum development, teacher development, and resource development (teacher guides) as iterative with each feeding from the others.

I had little option but to set up a traditional curriculum committee, but I asked them to decide what tasks might be considered by other teachers between our regular week-long residential meetings that were held each 3 or 4 months. This ensured that more people were involved. Between the curriculum committee meetings I organised regional working groups for week-long meetings to work on assigned tasks.

A recent innovation within the division had been *exploratory* studies. The computer education group had a budget for and organized a large number of teacher initiated exploratory studies to find how teachers were using computers. My science colleague had budgeted for six 'exploratory studies' to obtain teacher-research on six aspects related to the science curriculum that concerned her. I thought such studies would be a way to have more teachers participating in the curriculum process with studies involving teacher research, scholarship, trialling of units, and reporting in ways that could feed into curriculum and teacher guides. I expected that the confidence of the teachers involved would grow and that the pool of people to work on teacher courses would be enlarged. I set up 21 small exploratory study groups. I decided not to ask them to work on areas that I thought would benefit the curriculum, but invited them to put forward proposals on areas they believed would be significant. The groups had minimal support, I had no extra budget for them, but they produced many ideas that informed the curriculum committee and provided ideas for planned teacher guides.

In the 1980s most curriculum projects took between 4 and 5 years and generally relied on fewer than 40 teachers. Over the 3 years I involved about 240 teachers in working groups and 80 in exploratory studies. This did not involve all high school mathematics teachers (probably about 2000) but was more than the 40 usually involved in the curriculum process. In addition, I communicated with other teachers through a regular publication, *Mathnews*, to increase awareness of the project.

I found the curriculum committee meetings and the working parties stimulating and fun, however some participants thought they were sometimes too relaxed, and the following incident demonstrates this.

*Incident 7.7—All fun and no work!*

*While chairing the third week-long residential meeting of the F5-7 (Years 11-13) curriculum committee one participant compared our ways of working with another curriculum committee's ways. She said the others seemed more on task, their room was always quiet, they seemed more productive, and they worked longer hours, while our group laughed a lot, talked all the time, took longer breaks for morning tea, lunch, afternoon tea, and socialised with drinks instead of working after dinner. She said she felt guilty about leaving school a week at a time to have fun like this. I assured her what I took back to the office after each meeting was just as valuable as what my colleague in the other subject took from their meeting. I reminded her that we had decided to involve more teachers with intervening meetings and our discussions were important for the planning of these, and I asked her to reflect on what we talked about while socialising. She accepted that as we hardly knew each other, virtually all our small talk was work related.*

*I remained convinced that running a democratic meeting, ensuring plenty of informal as well as formal discussion occurred, not making hard and fast decisions too early, and revisiting ideas after discussion, and after trying some of these with other teachers was a productive way of working. When I compared the progress our committee made with that of other subject committees I felt more convinced than ever.*

During the last 12 months of this project I was promoted within CDD. I was more involved with administration, and supervision (and learnt more about other subject curricula). Thus, I could second a teacher to assist with the curriculum project. I accepted the teacher nominated by the local inspectors and they had chosen well. The teacher began by asking what he should do first. I replied, *Read as much as you can about curriculum, the development process, and what others are doing.* Later he told me that he was both pleased and surprised that I had not been directive. He enjoyed the work and the investment was worthwhile for the mathematics community; our project was never completed but he led the next review of the mathematics curriculum (Ministry of Education 1992) which was for all levels of schooling.

During the 1980s there was no *curriculum framework* or umbrella document, the aims of education were only implicit, and subject committees were mainly concerned

with subject aims. Even subject aims were not always to the fore; I recall a University Entrance Board committee when they had nearly completed a revised examination prescription (curriculum) and the chairman said, *we need to add the aims of teaching mathematics before we send this to the board for approval*. This apparent mis-ordering reflects: starting where teachers are, thinking about changes in content, and assuming the worth of what is being done can develop curriculum.

One major change with the draft curriculum (Department of Education 1989) was that teachers were required to select from over 40 modules of work at each form level, to choose between 6 and 10 modules for a course appropriate for their class. The suggested draft list of modules for form six (year 12) is listed in table 7c.

Table 7c: *Modules for form 6 (year 12) courses* (from Begg 1990)

Personal Planning	Mathematics of Finance
Business Mathematics	Planning with Networks
Calculation and Measurement	Algebra
Sequences and Series	Graphs
Mathematical Structures	Differentiation
Integration	Introductory Calculus
Probability and Data Display	Statistics and Sampling
Survey Design and Graphical Display	Variation, Curve Fitting, and Regression
Statistics as an Agent for Change	Matrices, and Transformations
Lines and Circles	Alternative Geometry
Topology	Trigonometry
Navigation and Surveying	Introduction to Logic
Machines	Linear Motion
Mathematics and Culture	Mathematics and Design
Mathematics and Music	Mathematics of Leisure and Sport
Mathematics of Health	Mathematics of Communication
Maths of Agriculture and Horticulture	Te Marae (Economics of the Marae)*
Nga Tohu Tuia (Plaiting Codes)*	Nga Tau Ahua (Geometric Numbers)
Nga Raranga Taniko (Taniko Matrices)*	Te Hangaia Marama (Analysing Statistics)*
Te Ara Whitu (Navigation)*	Te Tipuranga Tangata (Population Growth Rates)*
The Process of Learning in Mathematics	Project
Mathematics and Other Subjects	Development Module
Making Connections	

(The five modules marked \* were not in the original draft syllabus)



Each module outline included: aims, notes about possible contexts, content, suggested learning experiences, broad outcomes, and options; as illustrated by the form 5 (year 11) module about time, see table 7d.

Table 7d: *An exemplar module* (from Begg 1990)

**Time**

This module **aims** to explore the historic development of time systems and measurement, and to develop an awareness of measurement and accuracy in real life.

Ideas developed in this module should be in the **context** of the historical development of time measurement, and the practical investigation of past and present-day measuring devices.

**Content** to be covered should include:

- early forms of time measurement and division, early methods of recording time;
- the measurement of time using the sun's shadow—shadow clocks, sun dials, variations in shadow length according to season, trigonometry related to these measurements;
- other early measuring devices - hourglasses, candle clocks, calendars, water clocks;
- the properties of the pendulum, timing of swing, the mechanism of clocks, chronometers;
- the measurement of small intervals of time, digital clocks, 24-hour clocks, associated problems;
- time zones, standard mean time, relationship of local time to longitude, calculating travel times between different time zones.

Learning experiences should include:

- discussion about the use of time to measure distance in everyday life;
- designing, making, calibrating, and testing a simple time device;
- investigating the historic development of time units and measurement;
- applying time measurement to real and simulated experiences.

**On completion**, students should:

- be able to understand the need for universal time measurement and the units used;
- be able to use a range of modern timing devices with confidence and make time calculations related to their experience with accuracy;
- have made a simple time device which can give the time with reasonable accuracy.

**Options** include:

- electronic timing systems (especially in sports competitions);
- the use of appropriate technology;
- geological time;
- the history of time;
- designing a system of metric time units.

It was assumed that teachers could allow groups of students to be studying different modules at the same time in the same room or through parallel classes. Modules choice could and should involve student negotiation. The

array of possibilities was intended to provide a good discussion starter with parent groups (Begg 1990). The modules related to:

mathematical processes	traditional pure mathematics
applied mathematics (statistics/mechanics)	thematic mathematics
Maori bilingual mathematics	mathematics education
project mathematics	mathematics as a service subject

The development module was to allow further experimentation with alternative modules developed by teachers.

When the underpinning ideas behind the proposed curriculum structure were first discussed with teachers there was considerable anxiety. One concern was *no compulsory core*, though this was current practice in years 11 to 13. Thirty months later the draft (Department of Education 1989) was sent for discussion with a questionnaire. Respondents were asked about numerous aspects and to show with each whether they supported 'all', 'most', 'about half', 'some', 'did not support', or 'not sure'. The 110 responses (from 400 questionnaires) showed 80% supported 'all' or 'most' of the draft syllabus as a whole, the lowest percentage for 'all' or 'most' being 63% related to assessment and evaluation (Begg 1989).

My personal concern was that modules might lead to topics being taught as discrete units rather than with a spiralling that encourages revisiting topics, revising work (including work from previous years), and making connections between topics; but I assumed this could be covered in a teacher guide on designing courses. I was also concerned about expectations of students resulting from the 'able/less able' setting

that might result, but this was the current situation that teachers saw as ideal; and while *the quest, it seems to many of us, is to devise materials that will challenge the superior student while not destroying the confidence and will-to-learn of those who are less fortunate* (Bruner 1960, p 70), I was not confident that we would be able to produce such material. I also took comfort from Bruner's comment (1996, p 84), *You cannot teacher-proof a curriculum any more than you can parent-proof a family.*

I was pleased with the positive response and looked forward to involving more teachers as we worked on details within modules and teacher guides. However, a political swing in NZ to the new-right, a restructuring of the department, the closure of the CDD, and the emergence of a Ministry of Education with a different philosophy on curriculum overtook our initiative.

Our curriculum was never implemented. Some colleagues expected me to be disappointed but I felt that the curriculum process was as important as the product and that it was probable that some of the people who would be involved in the next project had benefited from their participation in this one.

## **7.6 Restructuring and moving on**

While in CDD I was concerned with the way some colleagues thought about their subject and its status, some seemed reluctant to cross boundaries or to question assumptions or superiors, and this made me wonder about our system. Such thinking ensured that our subject-based approach continues in schools. I had found that Maori people and those from Pacific nations did not partition knowledge by subjects, I was

concerned about disadvantaging them, and to overcome this I tried to present mathematics embedded in contexts and to emphasize connections.

I had seen how language influences understanding and misunderstanding (incident 7.6), and how different ways of knowing existed (incident 7.4) that I did not fully appreciate. I wondered again if mathematics teachers overemphasize logic.

In CDD I met the definition of curriculum as *all planned activity for the classroom*. This fitted with my teacher background and moved my thinking from what is taught to include how it is taught. It led me to see teacher guides such as *Ideas* (incident 7.1) as unofficial non-compulsory parts of curriculum. But, official curriculum documents were government policy documents. I interpreted curriculum policy as intentions and guidance, and catalysts for change, rather than statutory requirements for control and accountability. However, with the restructuring I saw this beginning to change with teachers' performance and children's achievement being emphasized.

I was surprised to find that in many regions (countries, states, or districts) curricula were increasingly becoming compulsory. I was surprised because teachers were becoming more highly trained and better qualified than ever before.

While working in CDD I reflected on my teaching career. I realized that my initial focus had been on subject knowledge and subject aims, and only later did this shift to general educational aims. As a teacher I had hardly considered how children learn. I asked myself then and continue to ask, Is this typical? Is this worse with mathematics teachers? Is it a male phenomenon? And, what might be done about this?

I knew about constructivism, and my focus shifted from what we teach to how students learn and how to teach. I had begun to see a rationale for different learning activities other than providing variation to prevent boredom, or fitting with Cockcroft's (1982) paragraph 243. I valued student-chosen extended projects and open-ended tasks from my own experience as a student and from the teachers of statistics, and I had emphasized such tasks in the teacher guides I helped produce.

I was wary of difficulties with internal assessment because of my experience with statistical projects (incident 7.2). Incident 7.3 with fractions had raised issues about assessment. These related to both technology and to what is assessed in terms of enabling *candidates to demonstrate what they do know rather than what they do not know* (Cockcroft 1982). My other concerns about assessment related to:

- Computers being used in mathematics classrooms but rarely in assessment.
- The value of high-stakes assessment was hardly debated.
- Teachers were divided about internal assessment versus examinations.
- New-right's ideas of accountability were being considered for education.

While in CDD I saw how robust ideas are hard to change. This had been exemplified in Vanuatu where English and French expatriates wished to maintain their different mathematics curricula when Vanuatu was working toward a unified curriculum (this was in spite of the fact that both the English and French curricula were ten years out-of-date in their home countries). Locally I saw teachers willing to change what they teach, but finding it more threatening to change how they teach as it seemed to threaten how they saw their roles as teachers.

I had come to value teachers' informal research (exploratory studies) and saw how this contributes to curriculum, resource, and teacher development, both for the person involved, and in building their confidence and expertise to share with others.

I had shared an office with a health education colleague. I appreciated her work with values—clarification rather than indoctrination. I believed relationship education was desirable; it was part of the health curriculum, but I wondered about teachers who had focussed on sport and their sensitivity to teach this. When CDD moved to an open-plan office and I was in a supervision role I learnt much more about other subject curricula and the ways my colleagues worked.

I learnt a lot while at CDD, but I acknowledge that some of it (e.g., women's ways of knowing, incident 7.4) was in my *head* rather than my *heart*. I continued to relate well with colleagues, but came to see close relationships as much more complex.

In 1987 I had been at a three-week workshop in Japan about technology and mathematics. The workshop was interesting and Japanese culture was fascinating. The workshop was in English rather than Japanese and the organizer told me that had it been in Japanese then younger Japanese participants could not question older ones, but being in English, western meeting protocols could be observed. From one young Japanese participant, I learnt how her husband, who she thought was tolerant, viewed her work and home responsibilities. I was aware of cultural differences between Japan and NZ, but what I heard seemed appalling. Then I realized it would have been similar in NZ not too long ago, and there is much to thank the women's movement for. My most significant learning in Japan was about my own powers of perception.

*Incident 7.8—Learning to see*

*At the workshop four of us used English as our main language, three knew each other well and spent their time together. I spent a lot of spare time in Tokyo by myself and noticed the architecture. For a change I was quiet. I had no one to talk to in English and no facility in Japanese. Throughout the three weeks my perceptions changed, I started noticing more things. I saw things differently. Finally I purchased a camera and recorded what I saw.*

*I thought about what was happening. My visual powers obviously always existed, but I had not used them before. What other unused powers do we have that education does not foster and perhaps even works against?*

*I later recalled how an aged aunt had told me about soldiers who had been blinded staying in her home. She had learnt how at the start they count paces to find their way around a strange environment but within weeks of being blind they did this automatically without thinking about it.*

*Learner's powers, children's powers, does education foster all of these? Mathematical powers too, do we really foster them?*

I had been on a restructuring committees in the Department of Education. I had not been opposed to restructuring—I believed it would give more responsibility to schools, and in terms of curriculum I saw this as schools having a freer hand to design their own curriculum. I had been concerned about the power held by curriculum officers—in general they had been good teachers but they tended to be single-subject focussed, few had a broad understanding of curriculum, and sometimes we were justifiably called *prima donnas*.

With restructuring I did not apply for a position in the MoE. I followed the woman I had been living with, took a career change, and took up a position at the University of Waikato. My curriculum work there is described in the next two chapters.

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## Part C      Reflecting on curriculum

### Chapter 8 Working at university

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#### 8.1 Starting again

From 1989 to 2000 I worked in an graduate research centre at the University of Waikato. The centre's work had been extended from science education to include mathematics education (and later, further extended to include technology and computing education). Our centre sat between the schools of Science and Technology, Computing and Mathematical Sciences, and Education. This period is summarized in table 8a.

Table 8a: *My eleven years at the University of Waikato*

1989	Appointed as Lecturer at University	Began my graduate research on professional development for high school mathematics teachers (also some work in areas of ethnomathematics and statistics education).
1990	of Waikato in a graduate centre	
1991	with sole responsibility for	
1992	mathematics education.	
1993	[teaching graduate courses mainly	
1994	to experienced teachers, and	Research interest shifted to learning theories and comparative curriculum (Attended night-school art class)
1995	supervising graduate research]	
1996		
1997	(Promoted to Senior Lecturer)	
1998		
1999	(Promoted to Adv Snr Lecturer)	
2000		

I was the first mathematics education lecturer at Waikato to teach graduate courses rather than pre-service teacher courses, and was involved with research and supervision. I did not have a masters degree, and had not taught such courses or supervised research, I was appointed because of my background. It was assumed that I would upgrade my qualifications, teach masters courses, and supervise research to doctoral level. In hindsight, with my lack of experience I should have been concerned, instead I was confident, perhaps arrogant, and certainly looked forward to the challenge. I sat in on science education classes in my first few months at the centre to get some idea of the content, standards, and expectations in a masters course. There was little cross-fertilization between the centre's subjects and as I was teaching the first masters-level papers in mathematics education in NZ I thought it desirable to network with mathematics educators working at other levels in NZ and internationally (in particular in Australia), to gain a greater understanding of what was happening in graduate study in mathematics education. Networking also provided opportunities for me to satisfy my 'conference addiction', and led me back to editing and writing two newsletters (ME/1–6, 1989–1991; ICME(NZ) 1–16, 1991–1999) and a yearbook (SAMEpapers, 1990–1999). I believed the yearbook would be useful to our centre and to networking institutions working in similar fields by offering papers that could be used in mathematics (and science) education classes.

## **8.2 Teaching teachers**

My initial challenge was to design the mathematics education course I was to teach. Having audited the centre's science education and then the research methods course, I planned the course (which later expanded into two). I chose four foci, learning,

curriculum, teaching, and assessment—these were related to my interests and I believed they were central to the work of teachers. Within these foci I included topics such as attitudes and anxiety, culture and ethnomathematics, and social and political issues. I assumed that most course participants would be high school teachers with good degrees in mathematics so the emphasis should be on education—*mE* rather than *Me* or *ME*). In fact numerous participants were primary teachers, and some high school teachers had little mathematics in their degrees; consequently I increased the emphasis on mathematical examples within classes.

I envisaged pre-service education and professional development as concerned with practice and graduate courses as concerned with theoretical underpinnings for practice more than practice itself. Students prepared for sessions by reading two or three papers, we discussed these papers and linked the ideas with our own. This ensured we started where the learners were and built on their interests.

Typically in the sessions of the learning and curriculum paper (Begg 2000b) we discussed: traditional learning theories; variations, implications and critiques of constructivism; cognitive science; neural Darwinism, and enactivism. Then continued with curriculum: forms of curriculum; content and processes; equity; contexts; technology; adult and teacher learning; and curriculum development. As we considered these we discussed about the implications of learning theories to curriculum and made links with parallel courses.

An aspect of teaching that concerned me was that many graduate students thought that they had to learn what others think (and cite the sources of such ideas) and their views were not relevant. For example, with learning theories they thought they must label themselves as behaviourists, or as social or radical constructivists. I attempted to counteract this notion that knowledge was outside them. Similarly in research methods, many thought that the course provided them with specific ways to do research while I emphasized that methods always need modification for particular situations and were intended to offer possibilities for them. The students who modified research approaches most readily were those from traditional overseas cultures who recognised the cultural inadequacies of standard approaches. *Learning what is taught* instead of *thinking for themselves* seemed to reflect transmission teaching and assessment of facts that many students had experienced when younger and still practised in their teaching. It seemed to me to be the antithesis of education and I encouraged participants to express and discuss their own ideas and to accept the possibility of simultaneously holding alternative and even contradictory ideas.

One example of this arose with a teacher from Fiji.

*Incident 8.1—Sexing a child*

*The question being discussed was—a mother has four children, they are all girls, she is expecting another, what is the probability that it will be a girl. The teacher in my class said that there were three answers. Others in the class were most surprised. The teacher said (paraphrased) “In biology it would be said that sex was determined if she was pregnant, so probabilities were not relevant, but if guessing then about 52/48 in favour of a boy. In mathematics the answer would be  $\frac{1}{2}$ . But the sex of a child is decided by God, not by probability.”*

*This caused discussion in class, it reinforced the notion that many viewpoints are legitimate, that mathematics is merely one way of making sense of the world, and mathematics should not undermine other ways of making sense.*

Another way of having people express and take seriously their own ideas was suggested by a colleague, Magarida Cesar (Cesar 1998) from Portugal. As a graduate student she had attended weekly meetings with Piaget and colleagues.

*Incident 8.2—Piaget's way of working*

*(Paraphrased) "Piaget would ask us to think about some issue. He told us not to read anything; he wanted our ideas. A week later we discussed our ideas.*

*After the discussion he told us to read around the topic, often giving some possible readings. The following week we again discussed the same issue."*

*I thought that this strategy would work with graduate students. It would move them from not valuing their own ideas and might encourage creative and divergent thinking. (However I felt it would require a larger number of shorter sessions if we were to cover the course topics and I never tried it in class.)*

This question of 'thinking one's own thoughts' was compounded by the issue of *how one thinks*, and this was brought to my attention by two course participants.

*Incident 8.3—Visualizing and not visualizing*

*A colleague auditing a course (for professional development), at one session light-heartedly said, "Haven't you a diagram or a matrix to summarise that, you usually have one". She was correct; I used many diagrams and tables to make connections. Meanwhile, another participant looked away. She never copied a diagram or a table from the board. At one point I asked her why and she replied that diagrams never help her with ideas and she never used them in her tertiary teaching.*

*I had trouble with this, I knew that some people are not good at visualizing, but I wondered how one could teach geometry without figures or algebra without drawing graphs. Others in the class were also amazed, the woman was embarrassed by the attention, and I moved on to shift attention from her.*

*Later I thought how some textbooks I had co-authored had been 'translated' into Braille. I wondered what happened to the diagrams we had provided and how a blind person might 'see' these.*

*I also remembered hearing a 'statement' from a blind geometer. I was not sure whether it was true or not, but it had made me think. He was purported to have said, "The trouble with you people with sight is you cannot see. Think about this sphere we have been talking about. Can you imagine what it looks like from inside?"*

*Seeing, visualizing, and 'feeling' a shape, seemed very important to me, yet perhaps I have blinkers on!*

Incident 8.3 raised the issue of learning styles for me. My question, with implications for curriculum, was, if a student learns in a non-visual way should I teach to suit this student, or is it more important to help the student develop visual skills? On the one hand I know that one does not teach an Olympic swimmer to play football, but at what stage do we concentrate on developed abilities and when do we stop developing other abilities? My view is that this is not an *either/or* question, and the answer is an *and* one. In teaching if the emphasis is on different ways of working and multiple representations then one allows for different learning styles, *and* at the same time one encourages an exploration of and experience with alternatives. However, my view needs testing to see if this teaching emphasis is enough to help people learn alternatives, and it does contrast to my experience in Japan (incident 7.8) where another aspect of awareness was brought to the fore by my being deprived of my usual mode of being.

### **8.3 Doing research**

An early priority at university was to start researching; this was an expectation of colleagues, but also an expectation that I put upon myself and accepted gladly. In CDD it seemed that there was sometimes only limited take-up of innovations, I had wondered why, and thinking of the RDD model, I chose professional development for my research topic (Begg 1994a). This made me aware of many misconceptions I had about teachers as learners and me as a learner, and started me thinking about the complexity of development. Researching for a doctorate was my first opportunity to do academic research, and it made me aware of how teachers feel when they return to study after some years. In particular, questions arose such as, *am I really saying*

*anything significant? and who is ever likely to read this?* Slowly I realized, I was the main beneficiary of my research, I was not going to change the world, I was growing as a person, and might possibly make some small changes in the local environment.

These notions have also been stated by others, for example Mason (1998, p. 357):

1. The most significant products (of research in mathematics education) are the transformations in the being of the researchers.
2. The second most significant products are stimuli to other researchers and teachers to test out conjectures for themselves in their own context.

Indeed, I have written with colleagues (Begg, Davis & Bramald 2003, p 596) of the obstacles to the dissemination of mathematics education research, and how: *an obstacle may be desirable, and what is perceived as an obstacle by one person may be seen positively by others*. We wrote (pp. 618–625) of the research and the researchers (as well as teachers, schools, and the system) as potential obstacles to the dissemination of research. From this perspective obstacles are not always negatives; they exist as part of the complexity of development; and research findings can no longer be envisaged in simple cause and effect way as they were in the past.

Thinking of my research as personal learning led to me accepting scholarship as a form of research rather than merely as a part of research; and I gave more credence to scholarship in my research on professional development. I thought of professional development as teacher learning, and this led me towards more scholarship on learning theories. My ideas about constructivism have been outlined in 2.2. Another influence was due to my views about radical constructivism sometimes conflicting with colleagues' ideas about social constructivism. Taking theories as ways of making sense, I was able to merge the social and radical aspects, but in doing this I also came to see that my ideas about constructivism did not explain all learning.

I had written (Begg 1999c) about my concerns about constructivism and two of these seem important. Firstly, constructivism was only concerned with cognitive knowing and did not explain unformulated or subconscious knowledge, intuition or instincts, or how emotions are constructed and their role in learning. In writing this I misused the word cognitive, I should have used the word conscious; as von Glasersfeld (2000) pointed out to me, cognition means *knowing not conscious thinking*.

Secondly, no links had been made between constructivism and learning theories from biology. Constructivism was based on educational research and philosophy, but as work progressed in neural biology and evolutionary learning theories progress, I had hoped to see biological and educational theories coming together.

These two concerns led me to enactivism (Maturana & Varela 1980, 1987; Varela 1987, 1999; Varela, Thompson & Rosch 1991; and Davis 1996), as discussed in 2.2 and as a component of enactivism, to complexity (see 2.5). From my perspective I came to see learning and curriculum as complex systems, This meant that instead of taking a *mechanistic* or *cause and effect* view of curriculum and teaching and of teaching and learning, I began to envisage curriculum, teaching, and learning as each being influenced in a chaotic way by a multitude of competing influences.

Another emerging research area for me was ethnomathematics (see 7.4). This related to Maori education, *Mathematica Pasefika* (Begg 1991, 1992a, 1992b), and my participation in working groups at conferences. This had become urgent with the work on the Maori-mathematics curriculum, *Pangarau* (Ministry of Education



1994), and the need in class to discuss the differences between the Maori and English versions of curriculum—at that time the differences being in pedagogy rather than content. My interest in ethno-mathematics moved to include ethno-pedagogy. This was due to my view of curriculum including what is taught and how it is taught, and because I was becoming aware of different ways of knowing and coming to know.

My other main interest over thirty years had been in statistics education. I had been involved with this from 1969 (Begg & Thomson 1969) and it had been part of my work in CDD. I had presented papers at international conferences and written articles for journals (Begg 1988, 1992c, 1993b, 1995a, 1997a, Carr & Begg 1994; Vere-Jones & Begg 1989) and have continued this involvement since leaving Waikato (Begg 2002a, 2004a & b). I continued to read in this area as I saw statistics as important (not only as essential for full participation in modern society, but because it is meaningful for students, and is a context in which other mathematical concepts, e.g., number and graphs, can be introduced). I had seen statistics in schools evolve from a mathematical/probabilistic optional subject for senior students, through a more experimental phase, into an *exploratory data analysis* phase for all school students, and more recently being influenced by computer use.

For me these four research areas (professional development, learning theories, ethnomathematics, and statistics) impacted on curriculum, especially on mathematics curriculum; but I acknowledge that many other contributing influences also exist. Thus, for me these became not only areas of scholarship and research but part of my focus on curriculum.

Another aspect of research is supervising, reading, and examining theses. In terms of curriculum a particularly interesting thesis I read was by Neyland (2001). It was completed after he had finished leading the NZ 1992 mathematics curriculum project. He talked about the technicist approach to development, and the need for us to have an ethical approach. This shift in emphasis is important; he went further than I had done in thinking about teachers' voices and being more collaborative. This further reinforced my view that complexity needs to be acknowledged in the curriculum process, that curriculum comes from both policy and practice, that many voices need to be heard, and that top-down and bottom-up development should occur simultaneously and in a complementary manner.

I enjoyed supervising student research. Being the only mathematics education lecturer in the centre I was obliged to accept students working in areas other than my own. This was beneficial, it caused me to read beyond my areas of expertise—I felt duty-bound to lead in the first third of their thesis projects, keep up with the students in the second third, and learn from them in the final third. Some students worked in areas such as ethnomathematics and statistics education but even then I learnt through my interactions with them. One student I remember particularly well.

#### *Incident 8.4—The big S word*

*My student was working in statistics education, taking an enactivist perspective (and pushing my thinking about enactivism as she did so). She was looking at alternative worldviews and at unformulated (not consciously known) knowledge. She had used a number of terms with religious connotations and I had advised her to couch her ideas in the language of mathematics/statistics education to be acceptable. She had done this, but finally one day reacted to something I said, "Are you scared to use the big S-word?" I knew she meant 'spiritual,' and I admitted that I could not clearly say what I meant with the word and did not use it.*

*She said that I was talking about spiritual knowledge, so I should use the word.*

*I thought about this both then and for a long time afterwards. I felt/thought that 'spiritual' summed up some of my notions of self-knowledge and awareness of self-and-other and self-and-world, but I had not used the word. I knew that I was not unhappy to go out on a limb as a 'crazy', but I thought that I needed to be explicit about a term that I used. I had thought about a spiritual dimension within curriculum and learning and realized that I should use the term as others would have a better idea of what I was meaning.*

*Since then I have used the term and (surprisingly) always found it acceptable. And so, I continue to learn from those whom I teach.*

## **8.4 Researching curriculum**

In 1994, because of my interest in curriculum, my concern for alternative forms of curriculum, and my desire to find out teachers' reactions to the 1992 curriculum, I began researching curriculum. My project was intended to have four phases.

- i) An open response to issues about the curriculum and the development process to identify areas in which teachers' voices needed to be heard
- ii) A comparative study of mathematics curricula across a number of countries and regions of similar size to NZ
- iii) A detailed questionnaire to quantify concerns and preferences from issues identified in the first two phases
- iv) The publication of stimulus papers on specific aspects related to curriculum

The first and third phases have been reported elsewhere (Begg 1998a, 1999a) and my feelings about the findings from the third phase are summarized here. The second phase is the focus of chapter 9. The fourth stage did not occur as originally planned, but is occurring to some extent through my current editorship of the yearbook series *Curriculum matters* (Begg 2005).

## ***Introduction***

When the NZ educational department was restructured in 1989 the CDD was replaced by two groups, one with responsibility for curriculum policy, the other to ensure that contracts given out achieved these policies. This restructuring seemed logical but I was concerned with the loss of curriculum expertise (and institutional memory) as former members of CDD were not expected to bid for or gain contracts that were to be out-sourced.

Resulting from contracts the following were produced in the period 1992–99:

- a curriculum framework outlining curriculum principles, the essential learning areas and the essential skills (Ministry of Education 1993)
- a mathematics curriculum (Ministry of Education 1992)
- curriculum for science, technology, languages, social studies, health and physical education, and the arts
- nine parallel documents for Maori including Pangarau (mathematics), (Ministry of Education 1994)
- Te Whariki (the early childhood curriculum)
- specialist curricula for other subjects, especially for senior high school

With these contracts in the 1990s there was neither time nor budget for research; I saw them as *writing* curriculum rather than *developing* curriculum. Contracts only involved a small numbers of teachers (apart from those commenting on the draft). Dissemination was largely left to advisors who had not been involved in the writing. I was concerned about this. With the government decision that ex-personnel of CDD

should not be involved in contracts, my role in the production of the mathematics curriculum (Ministry of Education 1992) was a peripheral one as a member of the contract monitoring committee. I had confidence in the leadership of the mathematics contract. The project leader had spent time seconded into CDD, had read around curriculum, and had been involved with the draft F5-7 syllabus (see 7.5). In hindsight my confidence was justified.

My concerns about the curriculum contracts were:

- There was no time for debate about general or subject curriculum issues
- There was no opportunity for teachers to register interest and be involved with the project, while teachers formed the majority of each committee they were usually appointed from successful schools (white, city, upper class)
- Only a small number of teachers were involved
- The time allowed was inadequate for writing or trialling possible changes
- Feedback from teachers was sought when the project was nearly completed
- There was little discussion with teachers and they had no time to develop ownership of the new curriculum

My planned research was an attempt to compensate for the lack of teacher voice in the next round of development (which I assumed would be in the 2000s). I had two strategies in mind.

- i) To ensure that *exploratory studies* were set up to legitimate small-scale research with teachers trialling new ideas and making informed input into future curriculum

- ii) To identify people to lead or participate in future mathematics curriculum projects, to find what people thought were the important issues, to obtain an indication of the extent of people's feelings about curriculum, and to provide an avenue by which these people could consider new possibilities and engage in an ongoing curriculum debate

The grant application for the first study, the exploratory studies, was not successful as these were seen as development rather than research. Similarly my application to the MoE for the second study was also unsuccessful but my University provided some funds for this research.

### ***Finding concerns***

I designed an open-ended questionnaire, sent it to all schools in NZ (about 2000) in 1996, invited all interested teachers to respond if they wished to be involved, and 180 responded. I was happy with this number, it included people previously involved in curriculum and others who self-identified as interested. The respondents included groups with strong opinions at both ends of the spectrum—ultra-conservative to radical anarchist. I did not report on phase 1 but used the responses to structure a 'tree' to group common themes and opposing ideas about these. The 'tree' was developed further as I compared curriculum from other countries (see chapter 9).

### ***Quantifying concerns***

Using my 'tree', I designed a detailed questionnaire that addressed most of the issues that had arisen. This was sent in 1998 to the 180 teachers who had responded and to

20 others who had responded to an advertisement in the *Educational Gazette* that was distributed to schools. Teachers had three months in which to complete the questionnaire, and 138 people responded (43 teachers from 31 primary and intermediate schools, 87 high school mathematics teachers from 31 schools, and 8 mathematics educators working at the tertiary level). The school sizes and locations suggested a reasonable spread across the country.

Because of the small sample, the self-selection, and the extra explanatory notes added, the findings could only be regarded as generally indicative of teachers' views, but they provided ideas that future curriculum developers needed to acknowledge.

The notes that respondents added reflected different opinions, they added a human dimension to the research, they broadened the interpretation of questions, and they indicated the frustration that some teachers were experiencing as well as areas in which they felt good.

The 'tree' used to design the questionnaire had 16 main branches (table 8b):

Table 8b: *Curriculum questionnaire tree*

1 overall assumptions about decision making	9 assessment beyond the curriculum
2 desirability and status of national curriculum	10 content
3 school schemes	11 mathematical processes
4 resources	12 teaching strategies
5 curriculum purposes	13 equity issues
6 content organisation	14 curriculum development
7 curriculum framework	15 professional development
8 assessment and the curriculum	16 curriculum format

### ***A brief summary of responses***

Teachers felt that a curriculum should be visionary, provide a sense of direction, be useful on a day-to-day basis, and safeguard students who change schools. Most thought that schools should make more decisions about curriculum, resources, professional development and assessment, though not about assessment for awards. The majority wanted a national curriculum though half wanted choice within it; and school schemes and lesson plans were seen as the important curriculum documents.

One theme was the need for links and integration:

- links between content strands
- integration of the process (doing) strand and content (knowing) strands
- integration of the essential skills in the framework with the curriculum, and
- links between all subjects and learning areas

Generally responses reflected what had been happening in education recently, variations within school organization around the country, and the range of views that would be expected in a democratic environment. Overall, teacher opinion about the development process was clear—a large majority recognised curriculum development as ongoing and involving scheme writing and professional development. They wanted:

- local curriculum development to be recognised and encouraged
- changes to the curriculum to be trialled before being introduced
- consultation not only on draft documents, but on issues such as the need for change, the framework, assessment, and the curriculum development process.



### ***A personal reflection***

While acknowledging that some questions in the questionnaire may have been biased, and some were subject to too many 'ifs and buts', they generally represented the concerns expressed in the first phase of the project.

In reading and analysing responses and extra notes I was aware of an undertone, teachers were concerned about the extent of imposed initiatives into which they had had no professional input, yet they knew that they were expected to and would implement these even without adequate support.

For me their responses reflected their experience over the previous two decades. Teachers had not had adequate time to make changes nor felt empowered to consider or suggest alternatives. Many had not wanted to consider alternatives, they had been safe with the status quo and wanted no change. I concluded that less imposition and more experimentation, discussion, and stimulus with and trialling of new ideas is needed to increase professional debate amongst teachers.

## **8.5 Changing assessment**

After the mathematics curriculum was published and as the science curriculum was nearing completion, two assessment teacher guide contracts were advertised. I had been concerned for some years that the assessed curriculum dominated the official curriculum so I bid for the mathematics contract. My bid was accepted, and a colleague won the science contract. We communicated, decided to work

independently, but agreed to compare our guides towards the end of the contract period.

The guide I edited (Begg 1993a) focussed entirely on assessment within the classroom that would provide feedback to teachers, learners, and parents (and the community). There was virtually no mention of assessment for external awards. In the first few pages I discussed the purposes and principles of assessment, linked assessment with the curriculum, discussed the relationship of teaching and assessment, methods of assessment, and then planning for assessment. The main content of the draft guide was twenty-one case studies from teachers at all levels of school using different approaches to assessment. The introductory remarks and the case studies were followed by “points to ponder” as the guide had been planned as a resource for professional development and my intention was to stimulate discussion about new assessment practices.

My colleague working on the science guide concentrated on assessment for external awards—an area she was very knowledgeable about. The two guides were very different, yet both satisfied the contract specifications. The intention had been to send them both to all primary school teachers and to high school teachers of each subject. I sent my draft guide to the Ministry and included a note saying that we had seen each other’s work and did not think that both should be published and distributed as they gave different messages to teachers. (The result was that both drafts were given to a third person with expertise in both subjects, and he was asked to produce a single assessment guide for mathematics and science from our drafts.)

This experience made me aware of how contracts involving small numbers of people can swing to extremes and possibly waste resources, and how detailed specifications for contracts need to be made clear to the contracted parties.

I had tried to change assessment by introducing alternative modes. I believed that the draft I submitted was as good as other teacher guides I had edited while at CDD.

I was disappointed when the final guide was published as it did not include much of the material I had in my draft. On the other hand, I accepted that change is a slow process, and politics, power, values, and practical factors all influence change.

## **8.6 Interrupting with art**

After researching professional development, I enrolled in an art class. I had *failed* art at school but thought I could draw. At session one an interesting incident occurred:

### *Incident 8.5—Diagnostic art assessment*

*The art tutor began by giving us three small pieces of paper and asking us to draw a boat, a house, and the person sitting opposite us. When we had done this he walked around and gave us each a mark. I scored an 8 and felt good, 8/10 seemed okay, but as he continued I heard marks above 10 being awarded.*

*He then drew a series of pictures of boats, houses and people and labelled them 6, 8, 10, ... 18 and told us these were typical of drawings by children of these ages. He suggested that we would have been about these ages, when we had been told we could not draw.*

*Two participants reacted, one sobbed, the other screamed. Both had memories triggered and could recall exactly when they were told they could not draw.*

*I had never realized before how easy it is to teach people that they cannot do things. I wondered, how often in my classes had I taught students they could not do mathematics. I had known that expectations mattered, but had never seen such vivid evidence. I noticed as the course progressed the tutor always had high expectations of us and always affirmed our ability.*

The course proceeded but numerous strategies surprised me.

*Incident 8.6—Learning to draw what you see*

*We were drawing a picture of flower and some leaves in a vase, the tutor said, “No, don’t draw the flower and the leaves, draw the spaces between them”.*

*We were copying a picture of a man reading a book, the tutor said, “No, turn the picture you are copying upside down and draw it upside down”.*

*He explained he was wanting us to draw what we saw, not what we thought we saw.*

*Eight weeks later, with 2 hours/week, we had all drawn reasonable pictures of each other, of other objects, and had copied more complex drawings.*

*Reflecting about this class has been valuable. It was based on unformulated rather than formal knowing with techniques intended to make us focus on the unfamiliar.*

*Art is a construction of representations of reality and this is similar to mathematics, but perhaps in mathematics, like art, we sometimes concentrate on the wrong parts.*

*Baroque music was in the background, we were totally involved in the activities, time in class just whizzed by, Did the music make a difference? And, why does time drag for students when I teach mathematics?*

*I am sure that I have lots to learn from people who teach other subjects—the separation of mathematics education from other forms of education may not be helping this learning process.*

*(The course was based on the work of Betty Edwards, 1989)*

Perhaps I had taught students they could not do mathematics, but the system was teaching teachers they could not organise their own curriculum, they could not control their own professional lives, the system was disempowering them.

## **8.7 Reconceptualizing curriculum and development**

While at Waikato I kept in contact with colleagues who had moved into the MoE.

I had been on the Ministry’s ‘monitoring’ group to ensure that the contracted mathematics curriculum team met the professional contract requirements. However, the NZ mathematics education community was a small network and we all knew

each other. My main input into the 1992 curriculum project had been to ensure that all members of the contracted committee had copies of the *Standards* (National Council of Teachers of Mathematics 1989) as I believed that the most significant change should be an emphasis on the mathematical processes.

The standards had led me to consider mathematics in a two-dimensional (2-d) way, though the 2-d were not independent. My 2-d model had content strands on one axis and the process strand on the other, but the important thing was to get the processes recognized. I knew that my 2-d curriculum with communication, problem solving, reasoning, and making connections intersecting each area of content meant far too many *cells* and the curriculum would seem even more *overfilled*. To overcome this I thought of curriculum as being only a framework and that to move from the curriculum to the school scheme and lesson plans, teachers would need to think of good learning activities that covered a number of the *cells* my model created. I was worried that teachers would want a prescriptive list of such activities and although many good resources existed with such rich activities I did not want to see those decisions made centrally.

The mathematics curriculum (Ministry of Education 1992) was completed before the curriculum framework (Ministry of Education 1993) and this was another concern. While the mathematics curriculum addressed the aims of mathematics, it had not addressed the general aims of education that in the framework, nor the *essential skills*—communication, numeracy, information, problem-solving, self-management and cooperative, physical, and work and study skills. These related not only to

mathematical processes but to all subjects, and I saw it as desirable to link these skills and school subjects. I wrote about this (Begg 1993c), presented a matrix of essential skills and subjects as a way of thinking about it, and attempted to stimulate debate about subjects and essential learning areas. In attempting to reconcile these aspects of curriculum I later wrote (Begg 1994c) about content and processes but concentrated on learning activities or thematic approaches, not just across mathematics but over numerous subjects (though in proposing this I expected resistance from secondary teachers and was concerned that some primary teachers might use a thematic approach to teach less mathematics rather than to ensure it was well covered).

I was also becoming interested in the informal curriculum and the notion of popularizing mathematics. This was partly due to work done while comparing education in different countries which is reported in chapter 9. I had spoken to some teachers and colleagues about popularising mathematics (Begg 1995b) and discussed with them the idea of producing a resource book about the topic as a way of stimulating interest in the informal curriculum. This book project lapsed for a number of reasons, the main one being my fear that teachers would put energy into popularizing the subject with out-of-school initiatives instead of addressing the issue of why people get turned off mathematics within the classroom. One theme however did stay with me—if students, as part of school mathematics, were to make permanent exhibits (rather than the temporary ones they make for mathematics competitions) and have these set up in parks and public places, then perhaps there was a place for the popularization of mathematics within the curriculum.

My work on the assessment contract (8.5) had made me concerned about assessment and the way it was driving the senior school through awards and more of the school with testing for accountability. I saw this as likely to force a technicist curriculum and to de-professionalize teachers by taking more curriculum decisions from them.

I wrote (Begg 1998b) to summarize my thinking at that time. My view of school mathematics was changing because of the processes, the need to link with framework, an increased emphasis on conceptual rather than algorithmic understanding, new topics, technology, and culture. My view of learning was changing and I remember quoting from Stenhouse (1975) about knowledge being *primarily concerned with synthesis*, rather than analysis. At the same time the change to new-right politics and the way they envisaged curriculum and assessment as control mechanisms for *quality* and *accountability* were a concern. I was conceptualizing a model for development, not the linear RDD one, but one with four interrelated or integrated components (see figures 8a & 8b).

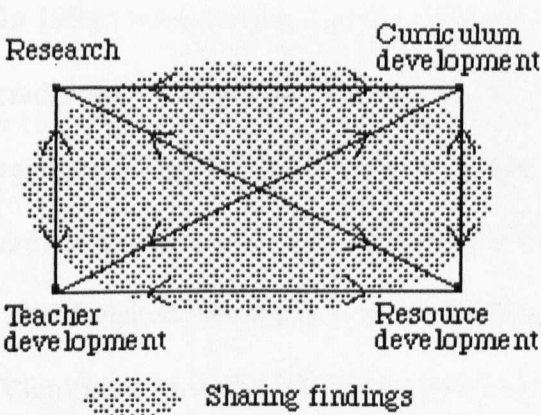


Figure 8a: *Interrelated components of development*

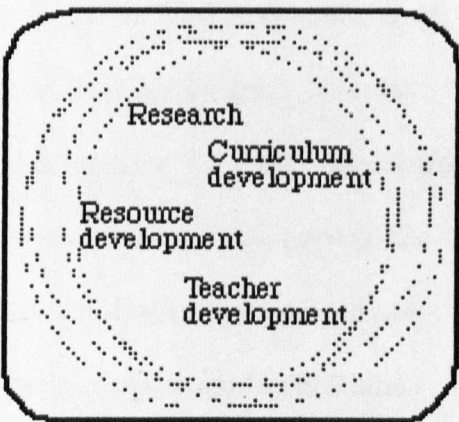


Figure 8b: *Integrated components of development*

Another concern for me was the emerging discussion about numeracy projects.

My first reaction was why *numeracy*? Numeracy implied having a basic ability with number, but mathematics is much more than numbers. Was this a new call for *back to basics*, was it pandering to teachers of younger children who felt safe with arithmetic and were still coming to terms with mathematics, or was it playing politics with parents who thought or felt that primary schools should concentrate on arithmetic? And, knowing about some overseas projects, can numeracy imply specific procedural teaching?

While working at the University of Waikato my thinking about curriculum and development had moved, but I would soon discover that the move had only just started.



## **Chapter 9 Comparing curriculum**

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### **9.1 Travelling and learning**

In 8.4 I mentioned that I used comparative research in other regions to help define a 'tree' for my curriculum research in NZ. This comparative research was undertaken during two sabbaticals from university and my focus was on differences from the NZ curriculum rather than on similarities as I was concerned with exploring alternatives.

In 1994 I selected five countries with national curricula and European educational traditions—The Netherlands, Denmark, Norway, Sweden and Finland. This was reported (Begg 1995c, 1995d), and some differences between NZ and these countries are discussed in 9.2, showing how they influenced my thinking about curriculum. In 1997 I visited nine regions in five federal countries. These were Queensland and Victoria in Australia, Manitoba and Ontario in Canada, Berlin and North Rhine Westphalia in Germany, Geneva and Zürich in Switzerland, and Massachusetts in the United States of America. This study was reported (Begg 1997b, 1998c) and the differences and their influence on my thinking are discussed in 9.3.

My overseas experience had begun earlier with trips to the Pacific, international conferences and workshops, an aid project, and the UNESCO Mathematica Pasefika project. While the time at these places had been brief I had always managed to discuss curriculum and associated issues.

## **9.2 Exploring options**

In 1994 I chose the Netherlands and Scandinavia to look at curricula. English is not their first language yet they are similar to NZ in size, and population, and have similar political and social environments. My aim was to meet and discuss curriculum in each country with a Ministry official and a mathematics educator, using an open-ended interview schedule.

### ***Curriculum***

NZ has a tradition of detailed national curriculum (Department of Education 1969, 1972, 1985, 1987; Ministry of Education 1992). The five countries in this study had recently developed national curriculum. The Netherlands curriculum was not compulsory in schools, and the Scandinavian ones were broad statements of intent that emphasised change and did not include detailed contents. Interviewees reported that the lack of prescription was part of being democratic and not dictating to teachers, they assumed choice was desirable, and that governments should not make curriculum decisions. The move in NZ a decade later towards a school curriculum with only a few pages for each subject could be seen to fit the notions of democracy and choice which I endorse, but until the emphasis on assessment and accountability change difficulties remain.

Interviewees claimed their curricula were influenced by constructivism. While the documents outlined general aims, philosophy or theory about learning was only implicit. This seemed desirable because theories evolve; different teachers interpret theories differently and have their own theories. I see statements on learning theory as useful in helping teachers become aware of new ideas, but they can also be obstacles to new theories emerging. I see teaching approaches being influenced by the provision of rich tasks (see table 11a) in teacher guides and resources rather than in official documents.

In terms of subject matter all the countries taught statistics, though by NZ standards, not much at primary school. I prefer NZ's position, but acknowledge that I have always had an interest in the subject, and I am currently concerned that statistics may be de-emphasised in future curriculum reviews.

The approaches to geometry varied. In the Netherlands the introduction began with what one sees in the environment and what one can draw. The move in Norway was to introduce more descriptive and intuitive approaches by using ideas of symmetry without a formal transformation approach. No approach was signalled as preferred in Sweden and Finland. The Netherlands and Norwegian approaches seemed to be forward steps, they fitted with the van Hiele Model of the development of geometric thought (Crowley 1987) which emphasized more informal work at the start of topics and I believe this has not been adequately considered in many countries.

With algebra the Netherlands was the only country that departed from tradition. Instead of emphasizing quadratics and factorisation they included general work about graphs and functions related to the students' world. This started with practical topics such as clothes sizes and used spreadsheets and non-standard graphs, and typified their emphasis on *realistic mathematics* with teachers using themes or contextual examples rather than traditional topics. These themes made connections between topics within the curriculum. Two examples of themes were flying (timetables, time zones, exchange rates, maps); and maps (topological, topographical, sea level and negative numbers). This emphasis on contexts can be argued as connecting with the world of the student, but also as providing concrete scaffolding for abstract ideas. My preference is for more contextual and thematic work in the NZ curriculum, but it needs a different style of teaching and teachers with a very good knowledge of mathematics. I see such a direction as, at least initially, being an option, a matter for teacher guides and textbooks rather than for the official curriculum.

The mathematical processes varied between countries. Emphasis was given to problem-solving, modelling, reasoning, communication, culture and history, and in Denmark, to structure. Processes were implicit in the Netherlands curriculum and not taught separately. For me culture and history seemed relevant in terms of ethnomathematics and the work of the international study group on history and pedagogy in mathematics education, while structure is important in pure mathematics and has been de-emphasized with the swing from new mathematics. While these are desirable they would require professional development for many teachers, but could be introduced as optional components of a curriculum.

### ***Curriculum development***

Two differences with the development process were noted, in the Netherlands the basis was the work of the Freudenthal Institute whose members had been involved in mathematics curriculum research for some years, and Denmark's way of making the change process more continuous by allowing schools to seek dispensations from sections of the curriculum and to try alternative topics. Both were desirable and both related to forms of research—intensive in-depth research and teacher trialling of alternatives. In NZ the research programme for mathematics education is not yet a comprehensive one, and while I have argued unsuccessfully for exploratory studies, other research initiatives exist that encourage some teacher research.

### ***Assessment***

Less examination pressure was evident than in NZ. In the final year of schooling in the Netherlands the mathematics results were based half on a 3-hour examination with four open-ended questions and half on internal assessment by the school.

In Denmark students sat two mathematics examinations at the end of year 9—one with a calculator, and one without. The results from these influenced advice given to students regarding their further education but decisions were left to students and parents. In years 11 and 12 there were written and oral examinations at the Gymnasia and at some other levels of secondary schooling.

**In Finland national examinations were only for year 12 students at the Gymnasium (the school for more able students); they were available in Finnish, Swedish or Same (Lapp) languages.**

**In Norway at year 9 there was a national examination in mathematics and in Norwegian. In year 10 the examination was only given to a sample of students. At year 11 few students sat the examinations as most carried on with mathematics to year 12. In the final year all students sat an examination in Norwegian, mathematics and some other subjects.**

**In Sweden there was no formal examination at the end of compulsory schooling but national tests are being trialled to ensure equity—the usefulness of these was still unknown. Only mathematics, English and Swedish were tested and this was only partly by examinations. For years 10–12 it was recognized that the cost of assessment for all courses was too expensive and no national testing system existed.**

**Concerns were expressed in terms of constructivist teaching and behavioural assessment. This was of particular concern in the Netherlands where separate agencies had responsibility for curriculum and assessment.**

**Two assessment innovations were noteworthy. In the Netherlands work had been done with two-stage tests with students having second attempts at a test and getting credit for this. In Denmark the use of oral examinations encouraged more oral work, student dialogue and student work on the blackboard during class. Typically in an**

oral examination at year 12 the students were given about 20 topics, asked to choose one, given 25 minutes for preparation, and then made a presentation and answer questions for 25 minutes with a teacher and an external moderator. Criteria existed for the moderators' comments but the mark awarded was holistic. A typical question was "How do you get the gradient of a tangent to a curve at a point on it, and how does this help you decide when a curve has stationary points or is increasing?" At year 9 the students were given six short questions, 30 minutes to prepare, and 30 minutes for a presentation and dialogue with their teacher on all six.

I am aware that since I visited these countries further changes have occurred involving more accountability. However, what I heard was relevant to NZ and the alternative modes of assessment seemed desirable.

### ***Teacher development***

Responsibility for teacher development generally rested outside the ministries; the responsibility to participate in professional development activities, apart from in-school ones, rested with the teachers. In Denmark most schools had two meetings each year and a retreat each second year to discuss future directions and curriculum matters. In Sweden the universities provided professional development and some Ministry personnel took leave from their positions to assist with this. Personally I would not favour the idea of universities having responsibility for teacher development, their input may be useful, but I feel that teachers should be in charge of their own development. However, the Danish idea of two-day retreats to consider future directions and curriculum did appeal to me.

### ***Indigenous people and minority groups***

In all countries in the study there were immigrants, and in Sweden and Norway there were indigenous people, the Same (Lapp) people. Teaching was generally only in the local language except in Sweden and Finland where students could choose to learn in Swedish, Finnish, or the Sami (Lapp) language. In the Faroe Islands, Greenland and Iceland (all independent states in union with Denmark) education was in the local language. Each of the five countries has only had one curriculum and other language groups translated from these. I was disappointed to find that more was not being done to cater for indigenous people.

### **9.3 Looking regionally**

In 1997 I used a similar interview approach as I had in 1994 and looked at the curriculum in nine regions—Queensland, Victoria, Manitoba, Ontario, Berlin, North Rhein Westfalia, Geneva, Zürich, and Massachusetts. In these five countries curriculum development was a regional responsibility, however, the regions were comparable to NZ with respect to population and/or area, and again had similar social and political environments, hence I regarded them as comparable to NZ. In three of the countries, Canada, Switzerland and the USA, curriculum decisions were expected to be modified at sub-regional level; in Canada at school district and individual school level, in Switzerland at commune (rather than canton) level, and in USA at local school board level.



### ***National Coordination***

Most of the nine regions I studied were influenced by some national/regional coordination. In Australia state initiatives were partly coordinated by the federally-funded Curriculum Corporation; and the Australian Education Council (1991) had published *A National Statement on Mathematics for Australian Schools* that had no legal status but influenced what states did. Similarly in the USA the *Standards* (NCTM 1989) influenced all states and the federal government influenced regional initiatives through regulations and by providing funds for research. Canada's federal government provided funds for education of aboriginal people and their national council of Ministers of Education organized joint projects including Western and Atlantic consortiums for mathematics. In Germany the Ministers of Education from the 16 länder met regularly and decided on common thrusts for development. In Switzerland there was no Federal Minister of Education, there were 24 cantons (seven French-speaking, one Italian -speaking, and the others German-speaking) and each was responsible for their own educational system; cantons that used the same language tended to coordinate curriculum activities and two research and development institutions had been founded and both served more than one canton.

Broad cross-regional initiatives had been argued for in terms of consistency and cost-efficiency, but seen in Canada and Germany, as limiting experimentation, teacher involvement in the early aspects of development, and the development of ownership of a project which was an important factor contributing to the success of a project. This recognition of potential dangers of cross-regional initiatives reinforced my view that we need to celebrate differences and encourage diversity and experimentation.

### ***Timing***

During 1997 the nine regions were at different stages of mathematics curriculum development. In Berlin the primary school curriculum was being revised but the high school one that dates from the new maths of the seventies was not seen as needing revision as it did not involve detailed operational objectives. In North Rhine Westfalia there were seven mathematics curricula for the different levels of and types of school, and while these were theoretically coherent, in practice each was revised as part of a response to expressed needs. North Rhine Westfalia aimed to revise curricula every ten years or so but this was becoming difficult and the upper secondary mathematics curriculum had not been revised since 1980. Queensland and Geneva had revised their curricula in the 1980s and had no immediate plans for reviews. In 1993 Zürich had brought out a new curriculum for all subjects, in 1995 Victoria had published its new mathematics curriculum and Massachusetts had been working from 1993 to 1997 on its first state mathematics curriculum. Manitoba and Ontario had reviews in progress during 1997.

These differences in timing seemed linked to the amount of detail in the curricula, and the number of different curricula for different groups. The North Rhine Westphalia aim of every ten yearly reviews seemed realistic, though I thought that it should be linked with the Danish view of allowing experimentation (9.2) and this notion fits with the NZ teachers concern about imposed curricula (8.4).

### ***Influences***

Reviews were generally initiated by political pressure (back to basics, standards, accountability, and cost efficiencies) and by subject committees that create political

pressure. Neighbouring regional initiatives and curricula from other regions or countries written in the same language influenced regional developments. The non-European regions were influenced by or expecting to be influenced by region-wide high-stakes assessment, while in the non-compulsory school years assessment for entrance to university influenced most curricula (even when this was controlled by a different authority). No region said that their curriculum development was research driven although consideration was given to comparative studies such as TIMSS, and to the informal research of reflective teachers who provide ideas of good practice and feedback on drafts. No regions had an evaluation of implementation although Massachusetts intended to evaluate its new curriculum to inform future changes.

Overall the situation seemed similar to that in NZ and reflects for me an evolutionary process, although there does not seem yet to be recognition of all the influences on curriculum (see 10.2 and 10.3).

### ***Curriculum development***

To coordinate developments some regions had permanent subject committees with rotating membership to provide advice and guidelines for development. Projects in most regions were led by full time curriculum officers or consultant/advisers, but in other regions a seconded inspector, a university mathematics educator, or someone seconded as a curriculum officer headed the project. All regions set up development committee(s) with teachers, consultants/advisers, university mathematicians and mathematics educators participating, and in all cases teachers were in the majority. In some regions teachers applied to be on committees, in others they were nominated.

The time from deciding to review a curriculum to full implementation with resources in place ranged up to ten years. The trend was towards months rather than years with three years being regarded as usual. This variations were influenced by:

- the number of people involved and the extent of consultation between groups
- whether involved teachers were released from teaching during the project
- the frequency of meetings for the committee(s)
- if draft curriculum were tested (as in some regions)
- how much consultation occurred with schools
- how many drafts were circulated to schools for feedback
- whether curriculum development is separated from the teacher development,
- whether resources (teachers guides or texts) were prepared and distributed

The notion of permanent standing committees with rotating membership sounds appealing, though whether an official government one, or one set up by teacher groups is preferable is debatable. Even with a committee, one needs experimentation and debate to provide such a committee with a rich input of ideas, and that seemed missing in the countries in this study, they relied largely on what others were doing.

### ***Curriculum contents and structure***

Newer curriculum from non-European regions emphasised mathematical processes and content. Processes included logical reasoning, problem-solving, modelling, estimation, mental mathematics, communication, visualization, making connections, using contexts, applications, using technology. Processes were usually emphasised in the introduction or in a curriculum strand, they were not embedded in the content.

Content varied across regions. In English-language curricula the emphasis was on patterns in algebra, on statistics and geometry in the lower grades, and on number sense and estimation. The European curricula were similar to English-language ones from the 80s (with trigonometry and statistics omitted in the Zürich curriculum).

Ideas in the various curricula related to pedagogy included exploring, inquiring, connecting between topics and within maths, doing cooperative work, writing in maths, using open-ended and open response questions, and explaining and justifying answers. All these statements about pedagogy were only suggestions and the curricula all assumed that decisions about teaching should be made by the teachers.

Most curriculum content was listed in behavioural terms, but in Victoria the introduction to the curriculum stated that outcomes should not to be considered as a checklist and an atomistic outcome-by-outcome approach should not dominate.

A number of concerns about pedagogy arose in some regions, these included:

- Content was based on logical rather than psychological considerations
- Teachers lacked knowledge of concept development and learning theories
- Using students' questions as a basis for teaching seemed not to be accepted
- Teachers did not seem to share experiences to improve their work
- Discovery learning was given undue emphasis

These comments about content and pedagogy seemed to be evidence of most regions moving haphazardly towards what might be called an international curriculum.

The amount of detail in the curricula depended on whether they were seen as directive and controlling or guiding with the expectation that schools or districts would develop their own curriculum to suit their particular situations. One respondent remarked how curriculum was defined in terms of the direct outcomes of formal education rather than recognising the complexity of schooling and the influence that school has on aspects of socialisation, this comment about general aims was one I identified with.

Perhaps my biggest disappointment was how little was done for indigenous people and ethnic minorities. All regions said they had ethnic minorities and mentioned broad ability groups. In Europe many of the students from minorities, along with less able students, went after four years schooling to the third tier of high school (non-academic/practical) where it was left to teachers in those schools to cope with them. In these third-tier schools curricula varied and the expectations of teachers, parents and students differed significantly. Some countries translated curriculum documents for large language groups but not for smaller groups or aboriginal people. In Canada the first nation people were a federal not a provincial responsibility and in Victoria aboriginal people had been partially considered by the use of reference groups during the development of the curriculum. The needs of aboriginal people, ethnic minorities, refugees, less-abled, and gifted seemed left for teachers to address without support.

### **Teachers' professional development**

None of the nine regions integrated teacher and curriculum development, they all followed an RDD model.

In Germany teachers were regarded as being well qualified. They spent from five to seven years in preparation, they were assumed to be professional, and teacher development was their own responsibility—however, and in spite of the opportunity provided by teaching each day only between 8am and 1pm, most German teachers were reported as not involved in professional development. In North Rhein Westfalia the institute that developed curriculum had responsibility for teacher inservice, but teacher development was being reduced due to the lack of resources for education.

Manitoba had teachers from all districts involved in curriculum development and came the closest to my ideal with teacher and curriculum development being inter-dependent. Their development was based on the Western provinces protocol so the initial involvement of teachers had not been great. Teachers expected to participate in 10 days of in-service or administration work each year while schools were closed and schools budgeted \$450 per teacher for professional development. Generally in-service work related to the new curriculum and involved modelling the way that teachers might work with it. Change was expected to take 4 or 5 years, though this did not fit with political thinking as the assumption was that other subject reforms would follow mathematics and would impact on generalist teachers.

In Geneva the primary curriculum was supported by the *Didactic Services* who provided advice on teaching methods and on ways that the curriculum could be developed. For high school mathematics teachers the main foci for professional development was their professional societies and in-school department meetings.

In Massachusetts recertification required teachers to gain 120 points each five years; for mathematics teachers these were divided into 60 hours in general education and 60 in mathematics education. This pressured teachers to attend workshops and courses on curriculum and districts had to ensure that courses with this focus were available. While compulsory development and recertification sounded fine and was successful in some states, a number of educators were cynical about its effect—concerns were expressed about the professional development industry that had grown, and about teachers having satisfied requirements by attending courses but not changing their practice.

I see teacher development as a responsibility of teachers. Teachers do always keep developing, though not always in the desired way. The need is to provide opportunities to reinforce the desired learning, but from my perspective these should relate to practice, be ongoing, and be controlled by the teachers involved.

### ***Resources***

One way to assist the implementation of curriculum was by providing teacher guides and by ensuring that suitable textbooks were available. Most English-speaking regions were developing teachers guides (in print or CD form) though Ontario had decided not to. In North Rhine Westfalia it was felt that there was a conflict of interest with publishers. The teachers guides were not legally binding but detailed suggestions related to teaching methods, sample programmes, essential learning, links between topics and across subjects, assessment, ability-based outcomes, and other resources.



Textbooks were seen in many regions as the de facto curriculum and some countries had approval systems. In Australia schools were free to buy whatever texts they wanted and the situation was the same in Massachusetts (though half of the states in the USA have approval systems). Approval was required in Ontario. In Germany approval was also required though this was usually given unless the book contradicted the curriculum or contained errors. In Geneva textbooks were paid for by the state; in Zürich texts were produced and issued by the canton's publishing house and were seen to provide an interpretation of the curriculum for teachers. The provision of prepared texts and worksheets produced by experts was commented upon by one interviewee as de-skilling teachers, he believed that each teacher should prepare their own resources if they are to really understand the curriculum.

In contrast to these regional curriculum initiatives an alternative view was suggested in Canada by Taylor (1997) from Queen's University. He recognized the influence of textbooks in North America but saw a need for an extended problem-solving focus as used by some schools in Japan. His philosophy as summarized in his book by: *This is a collection of classroom problems; they are not meant to be simply inserted into the curriculum—they are the curriculum* (p 1).

#### **9.4 Learning informally**

While at Waikato I had been the centre's representative at two meetings about the local children's science museum. This raised my awareness of the informal education provided by such institutions. I had noted that mathematics had been included as part of science in fund-raising publicity and I wondered about possible mathematical

exhibits/activities. I knew many were possible. I had been the local organizer for the exhibition *Common Threads* (Mary Harris 1990) which the British Council had allowed us to display. This had involved local materials supplementing core exhibits and had been well received by school groups and the public. I had decided that while travelling I should visit other museums and note possible mathematical exhibits.

After visiting about twelve such museums in Australia, the United States of America, England, and Scandinavia, I was staying with a colleague in Luleå. He suggested that I visit their science museum, *Teknikens Hus*, and said that it was different. I had nearly given up on science museums, I had a list of hundreds of possible mathematics exhibits, but I was tired of the whiz-bang and rushing around of children, and wondered, whether this was education.

#### *Incident 9.1—Museum education*

*Teknikens Hus was different. It was quiet. Adults and children spent time interacting with each exhibit. Nobody rushed from one exhibit to the next. The exhibits seemed not atypical. I could not identify what made this museum unique. I sat quietly and watched. I wondered, 'are people different in the north of Sweden?' Finally I found words to describe the difference— engagement rather than enjoyment. But why?*

*I talked with the director. She had been with the museum since it started; had visited other museums, and had seen how they took a 'big idea' from science or mathematics and developed an exhibit to demonstrate it. She had not studied education but had heard the expression 'start where the learner is'. On this basis the exhibits at Luleå had been set up—starting with familiar things that visitors knew, problematizing the situations, and moving towards the underlying 'big ideas'. She told me to think about a context, for example, aeroplanes. Most museums tried to explain the principle of flight. She gave people the 'experience' of flying or an extension of this experience. Her exhibit was a simulator so a visitor could experience the challenge of 'landing' a plane at Luleå airport. Similarly, with the timber industry, each person worked on the problem of how to use a miniature mill to cut a log (30cm long) into timber (kindling, which was later distributed to locals).*

*When I returned to the displays I noted that she had been successful with every display. Each started with a familiar context and moved the public towards more understanding rather than trying to teach the underlying principle .*

*The word 'engagement' seemed apt; engagement is based on 'starting where the learner is' or on Vygotsky's (1978) 'zone of proximal development'. I needed to reconsider my list of mathematical exhibits.*

*Educational ideas in informal education are relevant in formal settings, but have I as a teacher started with theoretical ideas or where the learner is? My self-assessment suggests, fail! And, do curricula emphasize this adequately? Again, I think not.*

As mentioned in 8.7, I had been thinking about the informal curriculum and popularizing mathematics and had not carried on because of a concern that while this may be useful for the community, it would distract teachers from their main responsibility, the mathematics classes. However, visiting *Teknikens Hus* reminded me of the need for teachers in class to start where students are rather than with the big ideas of mathematics, and this was evident in the Netherlands curriculum.

## **9.5 Merging or diversifying?**

Two terms that are increasingly heard in education are globalization (relating to the whole world) and internationalization (relating to cooperation between nations). Both occur related to curriculum, and most aspects of curriculum occur in the documents of many countries, and many examples of countries/regions cooperating exist.

While benefits from cooperation exist, the danger of less experimentation, less involvement of teachers in development and less variation within curriculum concern me. This implies not globalisation, internationalization, or regionalism, but *small is beautiful*, and diversity needing to be celebrated with curriculum. Once diversity exists then cooperative projects that enable others to learn from successful initiatives are worthwhile, but even then new ideas need to be tested in new environments.

In this vein, international comparative projects such as SIMSS, TIMSS and PISA concern me. Politicians want their countries to be seen to be doing well, educators want students to achieve, but international comparisons run the danger of pressuring nations to change curricula to achieve goals that are generally accepted.

On the other hand, my experience in the Pacific and talking with educators from developing nations suggests that the cost of local development cannot always be afforded and that forms of regionalism are the most likely way forward.

Some regionalism, internationalization, and globalization are inevitable in our modern society but at the same, notions of small scale development and diversity need to be valued as they are likely to be catalysts for change.

## **9.6 Reflecting on comparisons**

These two comparative studies were completed in 1994 and 1997. At that time versions of constructivism were used to explain learning and the RDD model for curriculum development was generally accepted. While countries and regions have probably moved on in the last decade, my intention in reflecting on these comparisons is to highlight questions that contributed to my emerging thinking about curriculum.

Should an official curriculum be detailed or very broad? Should a curriculum be mandated as compulsory, indeed can a curriculum ever be made compulsory? The studies illustrated that different possibilities work in different situations. I feel that

more thinking is required about the particular forms of curriculum, and these reasons should be discussed by teachers as well as by politicians. There are however many ways of empowering teachers, one way may be to allow more variation as is done in the Czech Republic (Kotásek & Svecová 1995) where an approved curricula exists but a 10% to 40% variation is allowed in some subjects at school level and individual teachers can make further changes of up to 33%.

What is the curriculum code (the philosophical or theoretical foundation) that underpins a particular curriculum? Should this be made explicit? Should a curriculum include pedagogy as well as content? If so, should pedagogical theories be stated or should pedagogy be restricted to desirable teaching strategies? Teachers seem to value practical strategies more than learning theories, but many teachers have a limited knowledge of pedagogy, so, should curriculum put much more emphasis on how to teach rather than what to teach? In terms of learning theories, how might the assessed curriculum fit with the official curriculum? If mathematics is a way of *making sense of one's world*, should there be cross-subject links so that students can see similar and different ways of making sense? I see a need for underpinnings to be at least partially explicit, and to have been debated so teachers can appreciate the rationale behind an official curriculum.

Policy pressure dominates change in education, but whose policy should be heeded? Mathematics is for all, but the voices heard most often in the development of the mathematics curriculum are those with a vested interest in school mathematics, academic mathematics and statistics, and mathematics education. Should more

voices be heard? Should the opinions of prospective employers, community leaders, parents, teachers of other subjects, and the learners themselves also be sought?

Is the content or what students *know* of prime importance, or is it more important that students can *do* mathematics, that is, use the mathematical processes (reasoning, problem-solving, and so on)? Is *thinking* mathematically (a notion that did not arise in any interviews) more important than the related knowing and doing mathematics?

Research, assessment, resources, and teacher development are recognized as influencing curriculum, curriculum development and curriculum implementation, so, would it be preferable to integrate these activities?

For me these questions imply finding a model for development that is more appropriate than the present RDD one, and have led me to broaden my definitions of five activities— curriculum development, research, assessment development, resource development, and teacher development.

In every region there are marginalized people. Does (and can) the curriculum provide for all people, for the majority, for indigenous minorities, for new immigrants and refugees, for a range of abilities, for people with disabilities, and for those from different social, economic, or cultural classes? Can and should mathematics be taught in other languages? Should aspects of cultural/ethno-mathematics be included? Most people see the purpose of education as extending everyone, but does a middle-upper class curriculum merely preserve privilege?

In the late 1990s these and other questions caused me to think of curriculum and curriculum development not as independent but as interrelated, and as complexly linked with other development activities. The notion of the learner as a living complex system that continually evolves had a parallel with curriculum. I now see curriculum also as a complex *living* and evolving system, and as I thought about this I slowly developed a model that I first presented in 2001 (Begg 2001c & d) and discuss in 10.2.





## **Chapter 10      Enjoying semi-retirement**

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### **10.1 Easing off**

In mid-2000 Waikato University I was to move from my position in the centre to the department in the School of Education which had responsibility for mathematics education and pre-service teacher education. I favoured this move as I believed that mathematics education should not be split across two units and thought it would strengthen the department's research capability. After the decision was made about this restructuring we were told that our department was overstaffed. I was the closest to retirement age and happily opted for early (semi-) retirement. The University had funded a sabbatical and it was agreed that I would be allowed to complete this in the second half of 2000. After that I expected to work as a consultant on projects. I envisaged that these would be linked with curriculum and my other interests, though that would depend on the opportunities that arose. My first six years of semi-retirement are summarized in table 10a, although I am not sure about even the 'semi' part of the retirement.

Table 10a: *So called 'semi'-retirement*

2000	2 <sup>nd</sup> half	Sabbatical	Australia, Japan, Taiwan, UK, Canada, USA (Attending conferences, and visiting and working with colleagues)
2001	Term 1	Visiting Lecturer	Inst. for Educational Development, Aga Khan University, Karachi (Assisting with intensive maths ed masters course)
	Term 2	Visiting Lecturer	University of Auckland (Teaching graduate class)
	Term 3	Visiting Academic	Monash University (Interacting with colleagues)
2002-2003		Contract Lecturer	Open University (Preparing course material for courses on mathematical thinking and geometric thinking)
2004		Contract Writer	Open University (Writing course material)
		Part-time Lecturer	University of Auckland (Teaching graduate class)
2005		Part-time Lecturer	University of Auckland (Teaching grad & undergrad classes)
		Part-time Consultant	Consultancy (Curriculum and adult numeracy)
2006	1 <sup>st</sup> half	Part-time Consultant	Consultancy (Curriculum) & final write up of this study.

When I started retirement my view of curriculum and development was not clear. I had ideas about what was important and some partially contradictory notions. I had no organized set of principles for curriculum or development. I was content to hold my chaotic jumble of ideas in my mind and allow my unconscious to process them.

After two years doing contract work related to aspects of curriculum, I decided to write about my lifetime of curriculum experiences to help get my past work into perspective and review my direction. I continued writing on curriculum and my thinking kept moving. My sabbatical had been planned so that I could attend conferences, interact with overseas colleagues with whom I had previously worked, and write the final versions of four chapters for books that were related to curriculum (Begg 2003a & b, Baker & Begg 2003, Begg, Davis & Bramald 2003).

While thinking and writing these chapters three aspects of my thinking were evolving and progressively became clear to me, these involved:

- envisaging curriculum and curriculum development as inseparable (and from here onwards the words *curriculum* or *curriculum development* are intended to include each other), and seeing curriculum development as connected to other forms of educational development
- seeing *curriculum development* and *educational development* as complex 'living' systems with one nested in the other
- developing a model that brings together the activities that impact on the curriculum/educational development system

### ***Inseparability***

The notion of inseparability of curriculum and curriculum development was implied by my definition, *all planning for the classroom* (although it took time for me to realize this). Curriculum is not what is planned, it is the planning. Curriculum, documents, schemes, lesson plans and changes made during teaching to make the most of opportunities that arise are all curriculum. Curriculum documents are part of curriculum-in-progress as teachers over time implement, reinterpret, ignore, modify, and move past the different parts of the document. Official documents are only *signposts* in the ever-changing environment of the curriculum that is influenced by teachers' confidence, their familiarity with their classes, available resources, and assessment requirements. The interrelatedness is apparent; practice is influenced by planning and planning by reading documents, what is written in lesson plans and schemes and, in the long term in official documents, are influenced by teacher practice. As such, a curriculum is never a finished product, it is always in-progress, and curriculum statements are only starting points for modification.

From this perspective curriculum developers (including teachers developing curriculum) are stimuli or catalysts for change, conscious/aware agents in the dynamic evolution. This brings ethical difficulties, developers have goals and agendas, and a major difficulty is to find a *fit* with the goals and agendas of the institution(s) and people for whom the curriculum document is being prepared.

### ***Complex living systems***

I see curriculum as a *living system*. Capra (1996, p. 29) writes of systems as being complex if they have *connectedness, relationships, context* and *properties of the whole, which none of the parts have*, and these properties arise *from the interactions and relationships between the parts*. Maturana and Varela (1987, pp. 42–4), define a complex system as *living* if it is self organizing, self regulating and self-producing, and they define such systems as *autopoietic* systems. Further, Maturana and Varela see self-organization, self-regulation and self-production in biological organisms as causing changes in the nervous system, and to describe this they use the delightful phrase, *to live is to know*. For non-biological systems perhaps the word *living* could be replaced by *evolving* but I see the word *living* as suitable for non-biological systems, and curriculum seems to fit the above criteria.

In describing curriculum as living, I accept that evolution is not always in an *ideal* direction, it involves evolving to *fit* the educational and political environment. I see it as complex because so many influences act on it (see 10.2 and 10.3 for the model and a description of the influences). Because these influences are neither one-way nor have predictable outcomes, I see curriculum as a *living system*.

## 10.2 Modelling development

At the end of my time at Waikato I had written about the development process as involving four interrelated activities (8.7), research, curriculum development, resource development, and teacher development, but this did not go far enough, other influences also impacted, and I was starting to see how these might fit together.

In looking for an alternative to the RDD model many possibilities existed. Some have been summarized, for example Postlethwaite (2003, p 99–101) summarized seven models of research utilisation that were possibly relevant, these being: R & D, problem-solving, interactive, political, tactical, enlightenment, and research-oriented models. For him the *interactive model assumes an ongoing dialogue between researchers and policy makers. This is often a disorderly set of interconnections and back-and-forthness*. While with the enlightenment model *research can enlighten policy-makers and help to redefine problems*. And, the research-oriented model might be thought of as a *research-as-part-of-the-intellectual-enterprise of society* model. However, for me such models did not reflect the complexity of the process with research, policy and other influences in curriculum development.

I had taken too narrow a view by focussing on curriculum development and my thinking moved to educational development that included curriculum. I thought about the activities that influence educational development, how these activities co-emerge and how the interactions between them are two-way. There seemed to be eight main activities (although one could think of fewer or more according to how one defines each). These activities were—researching, reflecting on practice,

growing professionally, developing resources, developing curriculum, developing assessment, developing policy, theorizing. I visualized them as vertices of an octagon (or a total *octad* symbol) with the dotted sides and diagonals in the figure as representing two-way (or dialogic) interactions between the activities (see figure 10a). I envisaged these interactions as influential rather than causal. I published this figure (Begg 2001d) and the following discussion is paraphrased from Begg (2001c).

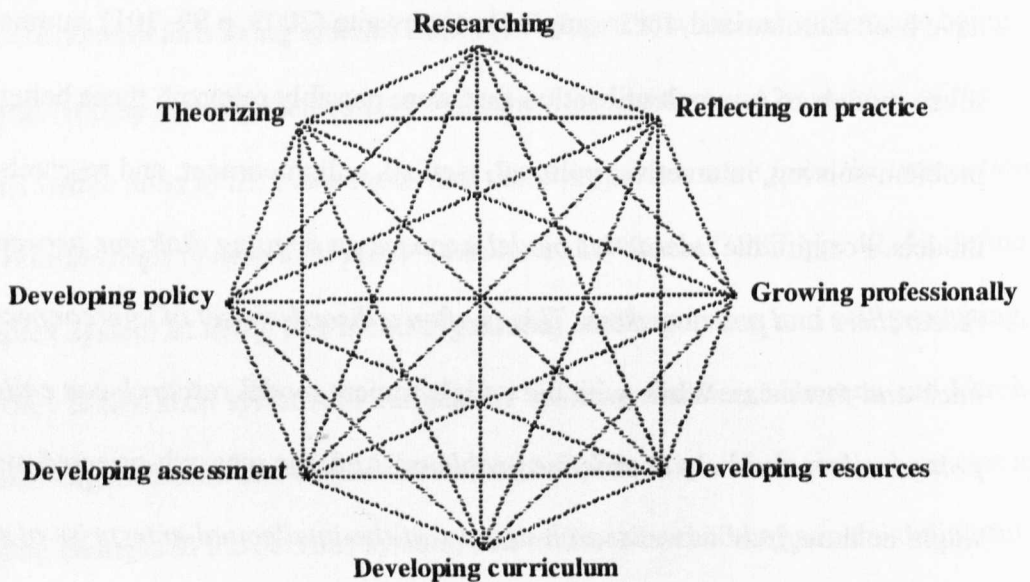


Figure 10a: *Eight co-emerging activities in educational development.*

The model is 28-dimensional not 8 because of the 28 dialogic links between the activities. It is complex—the activities impact on each other and the outcomes are unpredictable. It becomes more complex when one considers *ideas* flowing into the node activities from the environment in which the system *lives*.

One could interpret the model as suggesting that teachers are concerned with growing professionally and reflecting on practice, academics with researching and theorizing, and possibly as many as four other groups will be concerned with

developing policy, assessment, curriculum, and resources. This is not my intention. I see the eight activities as occurring at the individual teacher level, the school level, and the regional or state/national level, thus the model becomes even more complex. The interplay between levels introduces the ethical questions of whose authority, and whose final say? In not answering these questions the model shifts to a participatory-democratic one that reflects the interplay between levels, and the idea that development is neither top-down nor bottom-up, it is both-ways. It is made even more complex when development is considered as occurring over time (past, present, and future). In saying this I reject the proposition from Ralston (1994) of a *zero-based curriculum*. The past cannot be ignored, in teaching one starts where the learner is, and in curriculum and development one starts where the system is.

This model provides a way of thinking about the planning for any development initiative, it attempts to model the reality for development even though some activities may be ignored. It emphasizes the complex interrelationships between activities that continually impact on the ever-changing educational environment, and on the culture of change in the workplaces and professional life of teachers.

Perhaps this model should be illustrated with a 3 x 3 (or more) array of octagons. Moving from left to right one might think of past, present and future, moving from top to bottom one might envisage region, school, and teacher (or other levels). An alternative is to think about the basic octagon as two overlapping squares (the basic octad from Sufi traditions), with the square linking research, teacher development, curriculum development and policy development as being in the

background while to the fore is the what is often thought of as world of the teacher—reflecting, developing resources, developing assessment, and theorizing. My problem with this is that background and foreground in fact interact continually.

The model offered for change is incomplete. I have not explored all the ways that the links between activities operate, the ways of working within activities that might be desirable, or the ways that interactions between activities at different levels occur. I see each of the eight activities as complex and the groups of people involved in development as dynamic and self-organising systems. I acknowledge that a shape like an octagon may not be the most appropriate; it may be better to think of the model as a *web of possibilities* with the centre of the web being educational change.

If my model is perplexing because it lacks a straight-forward way of working then it is being interpreted as intended—there is no such way, coping with complexity can be overwhelming. I take heart in the saying *think globally but act locally*. It seems that we must do the best we can in the development activities in which we are involved, implement change in our immediate environments, accept complexity and don't lose heart when others are not willing to implement the same changes.

One question with my model is, is it a model or a framework? A framework usually helps with the process of making observations and noting relationships, while a model often implies a method. With complexity these two notions come together. A method is no longer a predictable way forward, it involves considering complex relationships that exist and ways of working without predictable results.



### 10.3 Detailing influencing activities

In table 10b I list references to my experiences and to signifying incidents that led me to my choice of the eight activities for this model.

Table 10b: *Activities, experiences and signifying incidents*

Activity	Experiences	Signifying incidents
<i>Growing professionally</i>	Chapter 4, Begg (1994a), 5.6, chapter 6, refresher courses, study, research	4.10, 4.19, 4.25, 4.26, 5.21, 5.22, 7.5, 7.7, 8.4
<i>Reflecting on practice</i>	4.7 teaching swimming, chapter 5, chapter 8, 9.6 reflecting on comparisons, chapter 10	4.1, 4.2, 4.6, 4.7, 4.12, 4.13, 4.15, 4.16, 4.18, 5.3, 5.8, 5.17, 5.20, 8.1, 8.2, 9.1,
<i>Researching</i>	Begg (1994a), chapter 9, this work	4.4, 4.5, 4.17, SIMSS, TIMSS & PISA
<i>Theorizing</i>	Chapter 8 (particularly while preparing and teaching graduates), chapters 10 & 11	5.1, 5.13, 5.23, 7.4, 7.8, 8.6,
<i>Developing policy</i>	Cockcroft (1982), experience as head of department, 5.3, 5.4, 5.5, 6.3, CDD	4.9, 4.11, 4.23, 4.24, 5.6, 5.7, 5.9, 5.12, 5.14, 5.15, 5.16, 5.19, 6.3
<i>Developing assessment</i>	8.5 changing assessment, Firsov (1996)	4.3, 4.14, 4.20, 4.21, 4.22, 7.2, 7.3, 8.5
<i>Developing curriculum</i>	Cockcroft (1982), chapter 7, Standards (NCTM, 1989),	5.2, 5.11
<i>Developing resources</i>	Chapter 6, 7.2 (teachers guides)	5.10, 6.1, 6.2, 7.1, 7.6

In offering this model I assume that other activities that influence development may exist and some activities could be merged. After the eight are discussed one example of how the model might be used is presented. The activity I have not included is developing relationship skills. This is because I see the development of relationships as occurring both outside and within all eight activities.

#### *Growing professionally*

Professional growth is often thought of as changing people. I assume one cannot change others; one can only change oneself. What is possible is to help others change if and when they want to do so. For me *growing professionally* is *learning while living as a teacher*. Such learning occurs all the time but is not always in the desired

direction. Teachers may consciously plan additional change, individually, with others, within a school project, or within a regional development activity. The resulting growth varies from individual to individual and may focus on personal, social or professional aspects or combinations of these (Bell & Gilbert 1993).

Traditional teacher development needs to be reinterpreted as providing opportunities for teachers to grow. Top-down development is not useful; the educators' role is to help teachers develop along the path they have chosen, recognizing that development is dynamic evolution rather than mechanical production. Within the change process development is not restricted to teachers, it involves all participants in a project.

### ***Reflecting on practice***

While a good teacher starts where the learner *is*, a teacher's practice is where the teacher *is*. I see reflecting-on-practice as a form of research (though others do not). I also see it as a component of growing professionally, but professional development can occur without reflection-on-practice, hence it is listed separately in the model.

Reflecting on practice includes observing/reflecting on the practice of others, and some of the incidents in my life as a learner (chapters 4 & 5) are examples of this.

Teachers typically are busy and find little time to consciously reflect, but conscious awareness of what one is doing, what one could be doing, and why one might want to consider a change, is likely to lead to development. Reflecting-on-practice can be an individual or group activity, and it may include feedback from students, parents, or the community. Reflecting-on practice is not restricted to teachers, it is desirable activity for all participants involved in change/development.

Reflecting-on-practice also occurs under other names, sometimes with variations in approaches. Mason (2002a) calls it the *discipline of noticing*, while Depraz, Varela, and Vermersch (2002) and Varela, Thompson and Rosch (1991) wrote about *becoming aware*. Some think about reflecting-on-practice as thinking about what has happened—I call this descriptive reflection. Reflecting-on-practice starts with this descriptive level, then one works at an interpretive level thinking about why things happened, and then, even deeper, examining assumptions and alternatives and drawing on theory, contexts, values, and so on. This deeper aspect is the *critical* level of reflection (Schön 1983), its aim is to critique assumptions made or acted upon, to empower oneself to act differently in the future; that is to anticipate possibilities.

### ***Researching***

Research is usually thought of as an academic activity but other forms exist, e.g., exploratory studies and reflection. I see the general view of research as needing to be expanded and new categories added. The NZ Qualifications Authority (1995) pushed for such a broader definition of research; they wrote of five (not mutually exclusive) types of research and two activities deemed equivalent to research, these were: basic or fundamental research, strategic research, applied research, scholarship, and creative work; and the equivalent activities were: consultancy and professional practice. Most educational research fits within this categorisation. I have extended it slightly (see table 10c) by adding other types of research. If these categories were accepted then *reflecting on practice* and *theorizing*, and some *developing* activities in my model might be subsumed under the heading research, however, I have retained all eight activities as this broad view of research is not accepted by all.

Table 10c: *Forms of research*

Category	Purpose
Basic research	to acquire new knowledge
Strategic research	to generate new knowledge in areas which have not advanced to the point where specific applications can be identified
Applied research	to develop knowledge for specific practical objectives (e.g., needs analysis)
Evaluatory research	to evaluate policies, programmes, or practices (e.g., curriculum evaluation)
Scholarship	to expand the boundaries of knowledge across disciplines by the analysis, synthesis and interpretation of ideas
Scholarship of teaching	to transform knowledge by bridging gaps in educational settings, (for example with exploratory studies)
Creative work	to generate ideas, hypotheses, images, performances or artifacts, leading to the development of new knowledge, understanding or expertise
Action research	to draw on existing knowledge, as well as contextual information and personal values, to develop and test new ideas in order to improve practice and thereby generate new knowledge (Haggarty 2006)
Consultancy	to work with clients in professional contexts in problem solving
Developmental research	to develop, trial and improve artifacts/resources for professional use
Hermeneutic reflection	to develop understandings, interpretations, and applications in professional situations
Professional practice	to theorise about professional practice and make such practice more effective

Research, like the other activities associated with development, occurs at many levels. Teachers can research in many ways—exploratory studies, action research, and informal enquiry that may not be written up, development research, and academic research. Similarly research can be undertaken by regional, national and international agencies. Research is often viewed as an input to the development process but I argue that the greatest benefit of research is to the researcher, and from this perspective researching fits within growing professionally— however, results from research can create opportunities for others to question their existing practices.

I see teacher research and local research as important for the development of self and practice, but I am concerned that little is done by teachers in terms of looking at issues of policy and curriculum development within schools. This is understandable

because these topics are broad, and conditions do not support teacher research, in fact they work against it. However, without such research there can be an overemphasis given to policy makers personal views and to politically-oriented commissioned studies that are not always neutral, and on international research which puts systems in danger of global changes being introduced (and for those of us in English speaking countries these may be another form of cultural imperialism by the Anglo-American world). Such changes can result from *manufactured consent* assisted by overseas *experts*, journals, and aid agencies. The underpinning but unstated assumptions of many such policies and curriculum include the view that the main purpose of education is to serve the development of the capitalist economic system based on consumerism, and ignore the ‘non-market values of humanitarianism, equity, and ecology’ (Ilon 2000).

### ***Theorizing***

Theorizing can be done at all levels; it can be based on research, scholarship, philosophy, and/or practice. For me the traditional tension between theory and practice is something that is partially nullified by enactivism in which knowledge is identified with action, though theorizing requires this knowledge to be made explicit. Building my model is an example of theorizing, and, like any theory it is not a matter of being right or wrong. Theorizing is useful when it helps make sense of what seems to be happening and provides better explanations than previous theories or models did. Theories and models will always be critiqued, some people may adopt a theory, others will adapt it and/or improve it, and eventually it will be replaced with a better theory or model—such is the nature of theorizing/model building.

Theorizing could focus on the nature of the subject, school mathematics, and how this is changing as mathematics (and statistics) changes, as content is emphasised less and processes more, as technology becomes available, as cultural influences are considered, and so on. Theorizing often begins with a question, for example, is mathematics a body of knowledge to be known (number, measurement, algebra, geometry, trigonometry, statistics, calculus), is it a human problem-solving endeavour (involving processes such as exploring, conjecturing and proving), or is it one way of making sense of one's world?

Educational foci for theorizing include the nature of curriculum and development; and also theories (or models) and related activities (or tasks) to improve learning, teaching, assessment, and classroom management. Theorizing about curriculum is important because, as Kemmis with Fitzclarence (1986, p. 82) said, education has taken a new form: *it concerns the role of schooling (rather than education in general) in relation to the state (rather than society generally)*. This change is not new, we are products of this form of education, so we need an awareness of other possibilities. Kemmis (1986, p. 113) provides a table (see table 10d) that provides one starting point to consider different perspectives on curriculum.

Table 10d: *Views on curriculum theorising*  
(Kemmis with Fitzclarence 1986, p. 113)

	Technical	Practical	Critical
Language & discourse	scientific	humanistic	dialectical
Social relationships & organization	bureaucratic	liberal	participatory-democratic, communitarian
Action and practices	technicist	rationalist	emancipatory (empowerment)

There is a danger in theorizing with too narrow a focus; broader theorizing is more likely to question underlying assumptions and these can be useful in identifying clashes that might cause conflicts. For example in theorizing about learning while considering more than one learning theory one finds that: behaviourism is concerned with the *analysis* of subject matter into specific objectives for teaching and assessing, while constructivism emphasises *synthesis* which requires us to look at the bigger ideas within our subject(s). Unfortunately some proponents of constructivism do not have enough subject knowledge to think synthetically and are content to promote guided discovery as a way of working and this is unlikely to be any more effective than other approaches to teaching and learning. In addition, if learning is based on constructivism and assessment on behaviourism we have theory conflict.

Another example of questioning assumptions occurs with the idea of *progression* that underpins curriculum structure and assessment. This notion emerged as people analysed subjects for teaching, but is now taken as the order for learning. This is reinforced by assessment (with levels) that reflect the behavioural ordering. In considering the different ways that learners construct their schemas it is possible to identify a range of learning *trajectories*. When progression is used as a basis for measuring performance it becomes a self-fulfilling prophecy but what is being measured may not be what is known.

A further example of theorizing applies to the place of applications in the learning and teaching of mathematics. From a behavioural view the basics come first, and when they are understood one might go on to applications. Others might argue that

an appropriate application of a concept is a form of *scaffolding (that) begins by luring the child into actions that produce recognizable-for-him solutions* (Wood, Bruner & Ross 1976, p. 96), such scaffolding being a form of what Ausubel (1978) terms an advance organizer. An alternative argument for applications is embedded in the notion of *specialising and generalising* where the *two important perceptions* are seeing the particular in the general and seeing the general through the particular (Mason 2002c, p.108); or, as Whitehead (1911, p. 4) summarised this, *To see what is general in what is particular and what is permanent in what is transitory is the aim of scientific thought*. A fourth perspective might be based on the argument that for understanding *we are forced to go one step beyond romantic hermeneutics, as it were, by regarding not only understanding and interpretation, but also application as comprising one unified process* (Gadamer 1988, p. 308).

There is an ethical question related to theories and models; does anyone have the right to impose a particular theory? I suggest that if a new theory is imposed many teachers will resist it, and that imposition may limit the exploration of new or alternative theories and progress may be hindered.

In emphasizing theory one core issue remains—does theory drive behaviour, or is theory a retrospective articulation designed to create coherence and make sense of actions. From an enactivist/complexity perspective this is not an either/or issue. Theories and behaviour changes emerge chaotically. As a practitioner develops an understanding of a theory, changes in behaviour may be suggested, but the development of understanding can also be reinforced by particular behaviours. This



emergent process can be considered as the coming together of reflection-on-practice and personal theorizing. My contention is that when a group is working on an educational project, coherence is needed, and the development of a shared theory (a theoretical framework) is useful for this. In general such shared theories are likely to have many commonalities with theories held by the community of practice.

### ***Developing policy***

The development of policy is often thought of as a national responsibility, but policy making is a multi-level process. Schools develop policies when deciding on aims and rules that determine school cultures. Teachers (often with students) develop policies then determine classroom protocols, and community expectations influence these. Thus people at all levels are concerned with developing policy. In addition, interactions occur between levels. For example, a classroom policy can influence a school policy, and a desirable school policy can influence other schools and later a regional policy.

My concern with policies is related to imposition. Policies need to be acceptable to people from diverse groups within a system, a school, or a classroom. It is interesting to look at the complex interplay between national policies and the espoused aims of education, the school and classroom aims and policies, the aims of mathematics education, and the enacted values of mathematics teachers and students in the classroom—a lack of coherence between these exists. This might result from a lack of interplay between levels over time that might have lead to compromise and a general acceptance of the policy without policy legislation being required.

Regional policies related to curriculum, assessment and resources have been used in various ways, sometimes to empower teachers, at other times to control what is done in classrooms. Such policies obviously influence the related development activities but the lack of wholehearted endorsement of these policies by schools supports the notion that links within the model are dialogical and influential but not causal.

### ***Developing assessment***

Developing assessment is another multi-level activity. National or regional assessment is common in many countries, and if common testing does not occur then forms of sampling to moderate internal assessment or to provide data on standards is common. At school level formal (summative) assessment occurs for records and reporting purposes, while in classrooms (diagnostic and formative) assessment is usually informal and intended to assist teachers in making planning decisions. One level often neglected is student's self-assessment yet if a school is concerned about developing autonomous learners, then self-assessment is a necessary skill.

National (and international) assessment has a marked influence on what is done in schools and has caused teachers to teach to the test, which means emphasising the things most likely to be tested or teaching the 'assessed' curriculum. This is unfortunate as 'not everything that can be measured, counts, and not everything that counts, can be measured.' School-wide common assessment tasks have a similar type of influence although usually to a lesser extent. The situation is exacerbated when results from such forms of assessment (rather than some measure of value-added) are used to justify merit payments to schools or teachers.

I believe that new assessment policies and strategies need to be developed that have less negative impact on learning yet provide the information that is *really* required, though what is really required, what for, and by whom, needs to be ascertained first.

### ***Developing curriculum***

Teachers see regional curriculum documents as related to their work, but these are also statements of government policy; thus developing curriculum is a policy activity. However, the impact of curriculum on teachers, especially in regions where it is compulsory, makes it important enough to consider separately. In addition, assessment policies and documents, ministry regulations, and teacher guides influence curriculum; it is not enough to think of one document as the curriculum.

The development of national/regional curriculum documents usually involves numerous teachers directly and more indirectly. If one uses my model then even more teachers would be involved in development activities. A national curriculum is interpreted during the production of a school *scheme* that takes into consideration the situation of the school, and then further interpreted to produce *lesson plans* for particular classes with specific resources, thus all teachers are curriculum developers.

With this complex-connected model for development I see curriculum documents as needing to reflect complexity. I would prefer a document that focussed on the *big ideas* of mathematics, but discussion would be needed to ascertain what they are. At the next level I would hope to see suggestions of successfully trialled tasks or *rich mathematical activities* (Ahmed 1987; Cox 1998) that could be used in the classroom

to emphasise the big ideas and to make connections within mathematics and with other subjects. The key at the individual teacher level of curriculum developing would be selecting and modifying appropriate activities for students and *curriculum anticipating* (Davis 1996), that is analysing possible ways that lessons might develop, working out likely paths that students may take, finding ways to extend activities, considering possible blind alleys, and so on.

### ***Developing resources***

One major resource is the textbook. In some countries, for example the USA, developing resources is regarded as developing curriculum. In other countries this is not so. With the RDD-model resource development follows curriculum development and the resources interpret curriculum and influence lesson planning and teaching.

Producing textbooks is usually a commercial enterprise undertaken by groups of authors; though sometimes research groups or education officials are also involved. Teachers become resource developers as they adapt texts and as they produce supplementary worksheets using ideas from other sources. When adaptations are discussed and worksheets are shared the influence of teachers as resource developers and change agents moves beyond the one-teacher level; though when teachers newly released from classrooms develop lessons for others they are often perplexed when others do not take them up eagerly. This also surprised the French didacticians following Brousseau who expected teachers to take up well-researched lesson plans. This reluctance suggests a need to empower rather than to impose, to accept that change evolves and that resources are only one influence on change.

After textbooks, calculators and computers are becoming the most important resource influencing both mathematics and mathematics education. The influence of this technology was summarised by Engelbrecht and Harding (2001):

- Some mathematics becomes more important because technology requires it
- Some mathematics becomes less important because technology replaces it
- Some mathematics becomes possible because technology allows it
- Some mathematics can be taught using technology

Thus, technological developments and associated resources will influence the mathematical content of the curriculum and the planning associated with the teaching. This is evident with programs that provide symbolic algebra, interactive calculus, dynamic geometry, and interactive-dynamic statistics—these are changing the way that mathematicians do mathematics and the way that algebra, calculus, geometry and statistics are taught and learnt.

Other teaching aids and equipment are available commercially, made by teachers for mathematics classes, or, more recently, may be presented visually on electronic screens. These also influence both the teaching and the ways that students think about the concepts being taught.

### ***Using this model—a case study***

For me this model offers a structure for making observations. To see this, imagine the notion *explore-conjecture-prove*. If a group wished to introduce this into schools because it integrates processes (problem solving, reasoning, making connections and communicating) with content strands, then what would they do? It would be difficult to work in eight activities at three levels, but there are things they could do.

Research might involve investigating practice in other countries and encouraging clusters of teachers to do small research projects within the constraints of the present curriculum to find ways how this notion might be incorporated would be useful. The results of these projects would need to be communicated so that others would be aware of the findings. Further research could include replications of trials with tasks so that other teachers develop ownership of these tasks.

Theories about *what mathematicians do*, about *learning*, and about how explore-conjecture-prove might fit with notions of schema construction could all be considered, developed, and discussed with colleagues. Such theories need to be reconciled with personal theories and shared and discussed so that others involved with the change become aware of the underpinning notions.

To influence policy members of the group will need to communicate with and lobby policy makers (classroom teachers, heads of departments, advisors, and curriculum developers). Communication is a two-way process—they may talk of their concerns, request possible solutions, suggest possible ways forward, and allow decision makers time to think about the idea. Such communication may occur when lobbying for a change or when make submissions on a draft curriculum document.

Assessment influences development so a need would exist to communicate with assessors, provide assessment exemplars and show (and justify) why it might not be desirable to assess it in other ways. This would require testing of exemplars and this

could be done with small research projects, with exploratory studies, or by encouraging others to test these which would also raise awareness of the initiative. To contribute to curriculum development tasks will need to be considered to develop the explore-conjecture-prove notion and these would need to be trialled to find appropriate stages to introduce the notion to students. Another contribution might be to consider how the notion could be used to integrate a number of curriculum strands. In each case groups could focus on the idea of *curriculum anticipating* and consider how such activities might be interpreted by students and extended to make more connections and suit different situations. Such a group working on curriculum development may not be able to do all of this themselves, nor would this process be seen as separate from resource and professional development, so the group would attempt to extend the number of interested people to achieve these goals.

In terms of resource development good tasks would be needed for all the classroom levels where the initiative was expected to occur. Some would be designed by the people involved, others would be encouraged to contribute ideas, some would be modified from other resources, and all might be shared through journal articles and workshops with writers of textbooks and teacher guides so that more people would see how the ideas might be integrated into the classroom.

People involved would ideally reflect on all stages of the process as it occurred and encourage others to reflect on the trialling of activities. They would not suggest that they had an *end* product, instead the group would continue to seek further ways to progress the original notion.

For the professional development component group members could attend and address conferences, present papers and workshops on the concept, and prepare kits for advisors to use in schools. At in-service courses *explore-conjecture-prove* could be built into other topics in the programmes, explicitly explored and discussed, and the suggested teaching might be modelled in workshop sessions.

While these eight activities have been presented as separate, they would not all necessarily occur, and they would be integrated as far as possible because of the interrelationships that exist between them. Being aware of all eight would make it more likely that individuals would support the retention and maintenance of complexity rather than attempt to over-simplify the process. All this would take a considerable time so that ownership of the idea would develop—this is important because teachers would not merely be being asked to change what they teach (content), but also to change the way they teach (identity). Modifications would occur and the breakthrough might be when the teachers pushed for a change in the curriculum, or when policy makers pushed and teachers accepted.

#### **10.4 Visiting other institutions**

In 2001, after returning from sabbatical and having an initial formulation of my development model, I spent three terms in three different institutions—the Aga Khan University in Karachi, Auckland University in New Zealand, and Monash University in Melbourne. At each I discussed my model with colleagues and students, interacted with their work and considered how that impacted on my model.



At the Institute for Educational Development (IED) in Karachi I assisted with a masters paper in mathematics education designed by colleagues from England. Students were experienced and successful teachers from a range of Moslem countries. (Most of these countries had been under British colonial rule and this legacy remained. It was evident in the showroom of a well-known British publisher. I believe that the books on display had not been available in the UK for at least ten years.) The IED staff members, expatriates and Pakistani, were very able. My general impression was that they were the experts and students would do whatever was asked of them—learn what was said, be able to talk about the ideas, and implement some of them in classrooms—I saw very little debate. It appeared to be *transmission teaching*, there was little evidence of questioning. The curriculum seemed to be a global one and cultural differences between England and the sub-continent were not acknowledged. Marton and Booth (1997, p 44) had said that Asian learners in Hong Kong using memorization successfully with each repetition *giving a new perspective on the content, and so an understanding was built up stage by stage*, but this was not what I saw in Karachi, it seemed to be memorisation with little thought. I tried to encourage debate, but perhaps I was not acknowledging the *respect* for the teacher that is part of the culture, and I accept that change takes time, perhaps more debate occurred in later courses. Regardless, the students were wonderfully warm, families were often discussed (most students were living at the university away from their families) and the general feeling that people mattered was more evident to me than it had been in other places. This was also evident with staff members, many worked hard for six days at the IED and did charitable work on the seventh day.

On returning home I found more debate occurred in university classes with teachers. Some reluctance still existed with those from Polynesia, perhaps a cultural respect factor, but teachers from various Asian countries discussed ideas freely. Learning seemed not so passive. However, when the focus was curriculum most teachers felt powerless, it had to be implemented, and they felt they had no part in its production.

At Monash University my colleagues were working on values in mathematics education. I had attended a conference with them, heard them speak previously (Bishop, Clarkson, FitzSimons, & Seah 2000), and was interested in their work. I gathered my thoughts about values in a position paper (Begg 2001e). I came to see values as knowledge, as something learnt, although often subtly. Some values seemed rationally considered and others developed subconsciously as unformulated strategies for immediate coping. I was concerned whether the aim was to teach values or have students clarify their own values and explore and empathize with the values of others. I noted that some aims in education are based on values that some learners and teachers see as undesirable and it seems desirable that underlying values are made explicit in curriculum. I came to see values as one of the many layers of knowing that exist within the personal (and social) environments in which we live and work—adding of course to the complexity of our work. Finally in 2005 (see 11.5) I saw a useful approach to values education.

As my year visiting these institutions came to an end a two-year contract position was advertised at the Open University (OU) in the United Kingdom. I successfully applied for it. The contract involved preparing course material for what became a

diploma for qualified teachers wishing to move into mathematics teaching; the focus was on mathematical thinking. The two-year contract was later supplemented by further work that I was able to do for the OU from NZ.

## 10.5 Thinking about thinking

My view of mathematics (and other subjects) had started with a content focus then in the 1990s it had become two-dimensional with content (knowing) supplemented by processes (doing). At the OU a third dimension emerged as the focus of my work—thinking. Thinking was also under consideration as a *competency* in the development of a new curriculum framework in NZ. To summarize my thinking about subjects changing I produced a figure (figure 10b) in a paper (Begg 2004b).

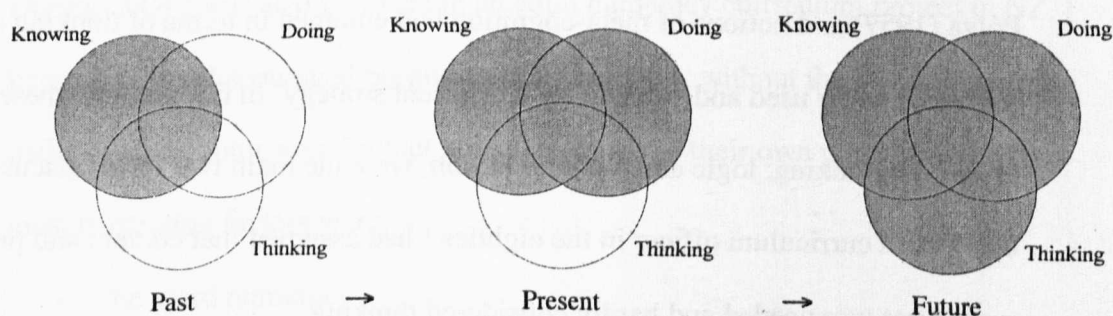


Figure 10b: *My changing view of subjects including mathematics*

Since then the main change I have made has been to overlap the circles more because knowing, doing and thinking are merely ways of looking at a subject. Content and processes in mathematics had been discussed since 1989 but what constituted mathematical thinking was not so clear to me. I knew that thinking is often thought of as within three categories—creative, critical and meta-cognitive thinking. All

three were relevant to mathematics but I thought that if a thinking curriculum was to be developed then the contributions of each subject needed to be specified.

My immediate task at the OU was to consider this in terms of mathematics generally, then later in geometry in particular. This was mainly to increase the emphasis given to thinking in mathematics, but also to provide a fresh approach to courses in a new diploma so that students would not be confronted with familiar school mathematics that they may have associated with frustration.

Learning mathematics at school, logic (proof and reasons) had been emphasised.

Then at university and with the introduction of new mathematics teaching logic was given even more emphasis. In problem-solving and applied mathematics at high school during the sixties and seventies there had been discussion of the ideas of Pólya (1957) and notions of meta-cognition had emerged in terms of thinking about strategies being used and when to try a different strategy. In my teaching these two aspects of thinking, logic and meta-cognition, were the main two forms discussed in class. As a curriculum officer in the eighties I had assumed that content and process were what was needed and hardly considered thinking.

While at the OU I delved into material for first year mathematics classes to explore thinking. From reading this material, and discussing it with my colleague John Mason, I came to see *generalising and specialising*, and *conjecturing and verifying*, as the two most important forms of mathematical thinking, with visualising and changing representations as the third. Conjecturing included a more creative and active role within logic than had been present in my past emphasis on proof.

With some ideas about mathematical thinking, my next concern was how to achieve a balance in between learning content, process and thinking. I considered how other subjects might balance these, and recalled the aim of teaching all subjects which I had often stated—each subject provides a way of making sense of one's worlds. I began to realize how curriculum emphasized the wrong thing, knowing rather than thinking, yet to make mathematical sense of one's worlds one had to be able to think mathematically. In reaching this conclusion I was aware that I had a significant knowledge of mathematical content and process and the way forward was to emphasize thinking without denigrating the other elements and make this thinking emphasis explicit through the language used in teaching.

### **10.6 Adult numeracy projects**

During 2004 I was also involved in an adult numeracy curriculum project in NZ. I became rather discouraged because tertiary teachers, without the restrictions of a national curriculum, were in fact not adventurous in their own planning. The three most frustrating factors were:

- the word numeracy
- the lack of acceptance that adult numeracy learners needed a different approach than they had experienced at school
- the notion that adult numeracy was merely a part of adult literacy

Numeracy has many definitions, the dictionary (Pearsall 2001) definition, *a basic knowledge of arithmetic*, seems to be how most people think of it. Within the project arithmetic (or number) was seen as the most important element although some other

mathematical knowledge and skills were required. There was no consideration that a word other than numeracy might better describe this project, yet the word implies for prospective learners, tutors, the public, and politicians that number is to the fore; and this is reinforced with the word numeracy in school mathematics projects that have led to more emphasis on number and less on other mathematical topics.

I believe that all school students learn successfully and that many who enrol in adult numeracy courses have very successfully learnt to hate or dislike mathematics. Thus, I believe that adult numeracy courses should not repeat school-type experiences for course participants. Other project members agreed with this but there was still the feeling that the first *outcome* of such a course had to be mastery of basic number skills and these had to be taught in a straightforward way. I argued for an approach based on thinking and problem-solving, but this did not fit with the outcome approach that some of the project team saw as politically pre-determined and as an approach that adult numeracy tutors would find acceptable. When we investigated adult numeracy course teachers we found that in many situations they were adult literacy tutors; numeracy was simply a few extra sessions for which these literacy tutors had no interest or training. This was reinforced when the draft report was reviewed by an adult numeracy specialist (a New Zealander working in Australia with a high school mathematics teacher background), he said that our proposals would not be accepted because adult numeracy was taught by literacy tutors. I wondered how the literacy tutors would feel if their courses were taught by numeracy tutors with little interest in literacy, and whether the government had any serious interest in adult numeracy if they allowed such a situation to continue.

The project was interesting as it involved some research where we interviewed people in a work situations to identify the required mathematical skills. We found that very little mathematics or arithmetic was used in most work situations and when it was used it was so contextually based that the users did not see it as mathematics. For me this raised the question, can one adult numeracy course suit a range of occupations or are specific occupation basic skills courses more appropriate? Unfortunately the second option was not popular with the project team.

On reflection this project was a typical failed curriculum project, but it reinforced for me that there was sense in my development model. The project seemed to fail because there had been little theorizing about what might be needed, there was no questioning of policies in particular related to assessment about outcomes-based assumptions, the reflection on practice was at a superficial level, there was no provision for professional development either for the project participants or for tutors, no consideration had been given to resource development, the research results were interpreted too narrowly, and the planning was towards an imposed curriculum.





## Part D                      Plateauing

### Chapter 11              Reconceptualizing knowing

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#### 11.1 Plateauing or concluding?

I have named this part of my study plateauing rather than concluding. I introduced the plateau in 1.3 and I think of the phases of my working life as plateaus that include sub-plateaus. The word seems appropriate as I report my emerging views of curriculum after 65 years because my life continues, I continue to read and think, and my ideas continue to evolve. It is also appropriate because my views are often questions and possibilities rather than solutions or conclusions. I chose plateauing rather than plateau as the verb implies a process, a pulling together of thoughts to date rather than the product of such thoughts. The word plateau [*an area of fairly level high ground; a state or period of little or no change following a period of activity or progress* (Pearsall 2001)] is not quite correct. It is still an upwards climb, though a gentler slope, as I re-examine the terrain of my beliefs, acknowledge what is still indistinct, and wonder about future possibilities.

In summarizing my thinking about *knowing* in this chapter and *curriculum* in the next, I acknowledge my ideas are not static. Indeed, as my colleagues read drafts of chapters they provided many references, however, as this is autobiographical I restricted my references to those that I had read at the various stages of my life and have kept their suggestions for further explorations.

This chapter is about knowing as the process of *knowing* or *coming to know* seems more important than the *product* or the *knowledge* that one knows. This process view of knowledge fits with that of Whitehead (1978), with what Dewey (1938a) said about experience. More recently Bereiter (2002) and Gilbert (2005) have written about knowledge in the knowledge age—in Gilbert's work she talks of knowledge as a verb rather than a noun. This also fits an enactivist view where *knowing is doing*, and *knowledge is enacted behaviour*, thus knowing and knowledge are processes.

Making ideas about knowing explicit seems important because a curriculum is based on such ideas and when these are not explicit misunderstandings can occur.

## **11.2 Knowing rationally**

Rational knowing is one form of knowing. It is about knowledge acquired through cognition—the *process of acquiring knowledge through thought, experience, and the senses* (Pearsall 2001)—and such knowledge is often expressed in words, discussed, and logically reasoned about. Other ways of knowing (see 11.3–11.7) are not separate from rational knowing but are complementary. Schools in the west focus mainly on rational knowledge, particularly with mathematics, though also with other

subjects. In such situations learners are expected to know, to do, and to think (if doing and thinking are emphasised) what is told to them, and are expected to accept it as *true* from a *higher authority* (teacher or text). Even when discussion is encouraged the learner is expected finally to agree with the authority.

When I first thought about knowing, in particular mathematical knowing, I saw it as putting together a jigsaw of discrete parts that made a large pre-determined picture (incidents 4.3, 4.4 & 4.5). I now believe that this was because of the behaviourist notions that prevailed at that time. I know my early teaching and textbook writing was based on such an analysis of the subject into discrete concepts with little thought being given to synthesizing ideas. Later the work of feminist writers such as Belenkey, Clinchy, Goldberger & Tarule (1986) raised my awareness of separate and connected knowledge and this concept of connectedness was further reinforced by the *Standards* (NCTM 1989) in the USA and by the notion of knowledge schemas associated with constructivism (see 2.3).

The work of Maturana & Varela (1987) and Varela, Thompson & Rosch (1991) emphasized this connectedness more strongly, they equated living and knowing. Their ideas on enactivism, together with those from the University of Alberta, in particular from Davis (1996), Davis, Sumara & Luce-Kapler (2000), and Davis & Simmt (2003) [see 2.3], developed this notion of connections in a complex way. The work of these writers implied unconscious/bodily knowing and a level of *awareness* that is usually not considered when thinking about schooling.

More recently Gilbert (2005) wrote about knowledge in the *knowledge society*. She critiqued the Platonic view of knowledge that schools have and identified a need to more closely align schools' view of knowledge with that held by business in the post-modern world. She saw knowledge not as a *thing* but as a dynamic process, as being *produced not in the minds of individuals but in interactions between people* (p 35). She critiqued learning skills and the current emphasis on knowing facts and suggested that education needs to involve more problem solving (as Dewey (1938b) suggested), building learning power (Claxton 2002, 2004). She also emphasized the need for schools to connect with more than subjects, to take a lead in transforming society to ensure that notions of individuality, identity and equality are to the fore, rather than allowing education to focus primarily on serving the economy. Gilbert's connections seem important to me as they link with my aims for education.

Writers such as these together with my experiences as a teacher led me to see knowing as a process and rational knowing as part of a more general knowing process. Within rational knowing I see three interrelated aspects—knowing, doing and thinking. While *rational* may imply well organised and logical, I see the rational knowing as complex/chaotic and messy, not as a simple mechanistic or well-ordered process. In such a situation learning *progressions* seem meaningless, each student comes to know in a unique way (though there is a need for teaching progressions).

While subject knowledge is regarded as rational knowledge it can be learnt in other ways. Many teachers believe that beliefs, values and attitudes are a different form of knowledge and are not the result of rational knowing. I see beliefs, values and

attitudes, at least in part, as rational knowledge, and individually and socially constructed in the same way as other knowledge. Some of the constructions are misconstructions, alternative constructions, conflicting constructions, or partly-formed constructions when one compares them with the social norms or the authority trying to inculcate specific beliefs, values or attitudes. Beliefs, values and attitudes can be discussed but often are not; if formal education is to address beliefs, values and attitudes, be it clarification, or being aware of one's own values and understanding those of others with empathy, then a rational knowing approach is needed to supplement the other ways by which these might be learnt.

Two concerns I have for students are:

- whether the rational knowing process in schools too heavily emphasizes thought at the expense of experience and the senses
- whether other forms of knowing are encouraged

My first concern is not original, it echoes what was said by many educators including Dewey, Montessori, Spencer, and even Plato who in the Republic praised Egyptian teachers for using apparatus. The second is more problematic, it might suggest *learning styles* or *multiple intelligences* but for me these are generally still forms of rational knowing; I am concerned about awareness and intuitive, sub-conscious, bodily, and enacted knowledge. These concerns are likely to be answered differently with different areas of the curriculum, and possibly differently in different cultures, but I see a need for them to be addressed in all areas, including mathematics.

My concern about connections with more than rational knowing or reason were reinforced by these comments of Saul (1992, p 15) talking about the 17<sup>th</sup> century:

Reason began, abruptly, to separate itself from and to outdistance the other more or less recognized human characteristics—spirit, appetite, faith and emotion, but also intuition, will and, most importantly, experience. This gradual encroachment on the foreground continues today.

Such a separation seemed to me to reflect our current emphasis on analysis without synthesis. There seems to me to be no problem in temporarily focusing on one human characteristic, but synthesis is needed and the results of any analysis need to be integrated with similar analyses of other characteristics.

### **11.3 Knowing emotionally**

Most educational aims mention three areas of development—cognition, self, and society. In the self and society areas relationships and emotions are recognized as important, but they also impact on cognition and on motivation. Some teachers address issues of relationships when teaching group work skills, but often only at the level of avoiding or resolving conflict. For me relationship education needs to address issues about the positive personal emotions as well as negative ones. I believe that just as we wish to inculcate a love of learning, an equally important goal is learning to love. Thus, while emotional learning in this study may be unexpected, the question of education about relationships and emotions is important to teenagers and adults alike. Affect, that is, *emotion as influencing behaviour* (Pearsall 2001) impacts on school behaviour and on other aspects of life. Apart from its importance in terms of schooling, education should be concerned with developing the whole person. So, while some education about emotions and relationships occurs in parallel to school learning, it seems desirable to me that it be considered in schools.

In subjects like mathematics students have feelings about the subject, other students, their ability, their teacher, and their school. All these impact on motivation and therefore learning. If a student cannot talk (to themselves or with others) about their feelings then this impact may well be negative. Reflecting and discussing feelings about a subject may be how students come to understand their emotions and see how these influence learning and behaviour. I see understanding one's emotions and relationships and being able to talk about them as very important.

Perhaps my view is prejudiced by personal experience. I accept that my lack of emotional knowing and lack of ability to talk about feelings impacted professionally and personally, on my life. Over 45 years, with two failed marriages, two failed long term liaisons, and currently a new relationship starting, the one thing I have learnt is that feelings are important. Yet many from the male half of Anglo-Saxon society have difficulty talking about feelings and showing empathy. I am not an expert in this area, but when thinking about what we know and the process of knowing I believe that emotions cannot be ignored.

Rogers (1969, 1978, 1980) and Fromm (1957, 1978, 1993, 1994) influenced my thinking regarding the interplay between emotion and education. Rogers raised my awareness of the way we separate intellect and feelings (1980, p. 249), he saw this separation as largely due to education, and yet he emphasised the need to be unified organisms, responsive to all of ourselves ... (1980, p. 253). Fromm provided me with an important rational perspective to support emotional learning. He saw love as *the only sane and satisfactory answer to the problem of human existence* (1957, p. 133)

and he discriminated between love *in the mode of having and in the mode of being* (1978, p 51). He made links between knowing and awareness or the spiritual dimension of knowing (11.5). From this I came to see that love is not merely person-to-person, it involves self-love and is part of person-to-world love/awareness.

Fromm's last book (1994) was about listening, and although it was written in the context of listening within psychoanalysis, it seemed to me to be relevant to the classroom. Reading this made me particularly responsive to what Davis (1996) was saying about modes of listening, and this also resonated with the need to develop empathy that is a part of emotional learning. Davis (1996, pp. 52–53) describes three modes of listening—the evaluative, interpretive, and hermeneutic modes.

- (i) Evaluative listening (hearing) is our day-to-day listening in which *we are often not aware of the biases that frame our auditory perceptions. ... Within the mathematics classroom, this manner of listening is manifested in the detached, evaluative stance of the teacher who deviates little from intended plans, ... where ... student contributions are judged as either right or wrong, and for whom listening is primarily the responsibility of the learner.*
- (ii) Interpretive listening is encouraged by radical constructivism with teachers trying to find *what learners are thinking*. This requires the teacher *to move away from an evaluative listening and to open up spaces for re-presentation and revision of ideas—to access subjective sense rather than to merely assess what has been learned.*
- (iii) Hermeneutic listening is unlike evaluative and interpretive listening that are based on the notion *of human identity and agency as essentially subjective,*



*autonomous, isolated and insular. Hermeneutic listening is more negotiatory, engaging, and messy, involving the hearer and the heard in a shared project. It is an imaginative participation in the formation and transformation of experience through an ongoing interrogation of the taken-for-granted, and the prejudices that frame perceptions and actions. The focus is on the dynamic interdependence of agent and setting, thought and action, knowledge and knower, self and other, individual and collective—rather than on autonomous constitution or construction.*

## **11.4 Knowing without knowing**

Another form of knowing is knowing without knowing. This sounds odd but we breathe without thinking about it, and our brains organise our bodies to sit, to walk, or whatever without conscious thought. As I type and think about typing I know that I have not consciously memorized my *qwerty* keyboard layout but my fingers often hover over the keys that I need. Such bodily knowledge is a form of knowing without knowing. The above examples may have been learnt by *experience* and possibly *thought* about at some stage, but other bodily knowledge such as the working of the immune system is a form of knowing that is more subconscious.

I classify intuition as a form of knowing without knowing, or what Polanyi (1958) refers to as tacit knowledge. It seems to result from a knower consciously meeting many concepts, the subconscious processing these further, then the knower intuitively concluding something that they had not been conscious of knowing. A milder form of this may be recalling a fact or word some time after giving up trying

to recall it; I often experience this when doing a crossword. Intuitive knowing seems evident with empathetic people who know what to say after *reading* a person's body language. In mathematics the *aha* moment (Gardner 1978) may be evidence of an intuitive jump. Within mathematics I remember reading (though I do not recall where) an anecdote about Professor Aitken, a New Zealander and professor of mathematics at Edinburgh. He was asked how he had contributed so much to mathematics. He replied saying that the hard part was not doing the mathematics but finding the questions. And went on to say something like: I have the question firmly in mind when going to bed, then in the morning I write out the proof.

I am indebted to Claxton (1997, 1999) and Atkinson & Claxton (2000) for stimulating my interest in intuition and how thinking can get in the way of learning. I see acknowledging intuition as important in all subjects including mathematics, partly because of the good sense that is often inherent in such ideas and partly because of the need to encourage learners to use all their learning powers. However, developing intuition requires developing a sensitivity to and an awareness of one's thoughts and feelings which leads into *becoming aware*.

## **11.5 Becoming aware**

Incident 8.4 (the big S-word) had made me rethink my ideas about spirituality within education, especially with respect to self-knowledge, connectedness and awareness. I had felt that *spiritual* had religious overtones and wanted to see it separated from this, but the word *spiritual* does have two meanings: *relating to, or affecting the human spirit as opposed to material or physical things*, and, *of or relating to religion*

*or religious belief* (Pearsall 2001). The first of these meanings, relating to the human spirit, fitted with my ideas, though I wondered if others saw it that way, and I was reassured to find Huebner (1985/1999) was concerned with the same issue when discussing spirituality and knowing.

My ideas of spiritual linked with

- *connectedness* within a systems view of learning and development
- *living in the moment*
- *awareness or mindfulness* or the personal and experiential development that occurs in the contemplative/mystic traditions of most religions (e.g., the mystics and Quakers in Christianity, the Sufi in Islam, the Kabbala in Judaism, the yoga of Hinduism and the meditative practices of Buddhism)

I see this awareness as starting with self-awareness and self-knowledge but not ending there; perhaps the aim is transformation or enlightenment, or as Blake (c. 1803) said, *to see a world in a grain of sand*. In systems terms I saw self-knowledge as contributing to an understanding of one's relationship with others and the world.

The word spiritual is sometimes used in curriculum documents, but I have not seen an explicit statement in curriculum of what is meant. I see *awareness* as an appropriate word to use, and see the development of this as important for facilitating emotional knowing, intuition, and other possible forms of non-rational knowing.

Awareness seems to capture what Merleau-Ponty (1964) called the *primacy of perception*, a pre-reflective awareness of *what is* rather than of *what is reflected*

*about what is*; and what Kabat-Zinn (2005) calls, *coming to our senses*. Awareness is also important in mathematics education, Cattengo (1988, pp. 10-11) expressed this as:

Man, the person, recognises that one or more of his awarenesses has a deeper reality than he now perceives, and he pursues its presence in himself. This is not only true of mathematics, but of all the exact sciences too, ... It is also true of the social (or human) sciences, ...

Awareness or mindfulness is often developed through meditation, for example Kabat-Zinn (2005, p 11) writes of paying attention, but suggests a specific programme for development:

Mindfulness is cultivated by paying attention, and, as we shall see, this paying attention is developed and refined through a practice known as *mindfulness meditation*, ...

Depraz, Varela, & Vermersch (2002) also wrote about becoming aware, they suggested a multi-method approach—introspection, phenomenology, and the contemplative traditions. However, the educator Langer (2005, p 5) claims:

... mindfulness is an effortless, simple process that consists of drawing novel distinctions, that is, noticing new things. The more we notice, the more we become aware of how things change depending on the context and perspective from which they are viewed. Mindfulness requires, however, that we give up fixed ways in which we've learned to look at the world.

With incident 8.6 (Learning to draw what you see) it was fascinating that the tutor had us shift our awareness from leaves to spaces between leaves so that instead of drawing leaf-like shapes we were drawing odd and different shapes that we had no preconceived ideas about. I wonder how often such shifts of awareness might assist knowing. I saw another aspect of awareness when I learnt to see (incident 7.8). I envisage developing awareness as enhancing one's sensory input, and enabling

something to be sensed without interpretation. This is valued in art, in other subjects, and in life, and is likely to be beneficial in mathematics.

There are different opinions about whether knowledge gained from awareness is an extended form of constructed/embodied knowledge, or involves accessing a sentient or universal consciousness, however this does not alter the value associated with awareness attributed by those who have developed such ways of knowing.

## **11.6 Knowing in the west**

Teachers often think about curriculum in terms of subjects. These are part of a western partitioning of knowledge that separates rather than integrates topics, and privileges academic knowledge over other forms. In addition, many subjects have been depreciated over the years by behaviouristic analysis that broke topics into measurable objectives involving facts and simple procedures. In terms of the analysis within subjects and the partitioning of subjects, the notion of connection or synthesis seems often forgotten. Alternative curriculum forms such as integrated (Clark 1997) or holistic (Miller 1996) curriculum may deserve consideration. However, in an integrated curriculum project in the 1980s we found resistance, in particular from mathematics teachers. Such resistance was itself linked with ways of working, ways that teacher development occurs (being changed by others instead of changing themselves), and with a lack of empathy or awareness of possibilities.

Hart (2001) considered this problem of analysis. He saw knowing and learning as unfolding through six interrelated layers—information, knowledge, intelligence,

understanding, wisdom and transformation (see 2.3). Hart believed that schools too often skim the surface of information at the expense of knowledge, intelligence, understanding, and wisdom. My belief is that schools do mistake information for knowledge and that wisdom rather than knowledge should be their concern. Hart's hierarchy involves more than rational knowing and these other ways of knowing need to be considered if wisdom is sought.

A further aspect of knowledge concerns emphasis. Western education since Plato's time has privileged academic knowledge. In the early 1900s with the development of technical schools in New Zealand more emphasis was put on technical courses, but in the 1980s when all schools were teaching both academic and practical subjects the status of subjects became an issue and again academic ones tended to be privileged. In practical subjects knowledge is about knowing *how* and *when*. Academic subjects focus on knowing *what* and *why*. These are not either/or positions, but alternatives within a range of possibilities—perhaps the ideal is to know less but to know *how*, *when*, *what*, and *why* about the things one does know. Of course the possibility one chooses depends on whether the knowledge is for practitioners, for everyone, or for anyone who wants it; and this links with responsibility, power, and the respect one has for specialist practitioners.

While ways of making connections that involve forms of knowing other than rational knowing are my main concern about western knowing, I am also concerned about two subjects that are part of the Western partitioning of knowledge but seem to be neglected in schools—religion and philosophy.

I think religion, especially comparative religion, has an important place in social studies. Students need to develop an understanding of the beliefs of others, in particular as countries become multicultural and as communication across the world becomes increasingly available, though in NZ it was needed even when the only comparisons were denominational—catholic and protestant. I would envisage such a comparative religion course moving into philosophy and the ideas of humanism and other systems to cover the belief structures of people professing no religion.

Apart from understanding beliefs, I see a need for philosophy, in particular, *applied* philosophy. In 2005 I was at the Australian curriculum conference and had the privilege of hearing Vaseo & Hinton (2005) talk about their school, how philosophy was a compulsory for students of all ages, and how the course involved discussion on a range of different questions about themes. These questions required students to discuss and think about morality, ethics, logic and other philosophical topics. This was not entirely new to me because a colleague at Auckland Metropolitan College had taught philosophy in 1977 and 1978. However, the Australian course differed, it was applied philosophy, the applications related to the lives of the children, they were thinking philosophically rather than learning what others had said and this thinking influenced behaviour. The school had developed a reputation for settling differences with discussion and negotiation rather than by conflict. It seemed that this course helped students explore their beliefs, values and attitudes, and develop empathy for those of others; it related to the problems in the students' worlds, and it continued the western tradition of teaching philosophy. I envisage that a philosophy

strand in the curriculum would be worthwhile, but wonder what would be required to encourage and facilitate more schools to integrate such a strand into their work.

## **11.7 Knowing in other cultures**

My interest in other cultures grew in the 1980s as I began to look at mathematics for Maori students. This developed with ethnomathematics, I attended conferences, and wrote (Begg, Bakalevu, Edwards, Koloto, & Sharma, 1996) about the content, processes and teaching of mathematics being influenced by the language, beliefs and experiences of the culture in which the teaching occurred (7.4). Rather than assuming western mathematics should be the starting point, Bishop (1988) argued that mathematical activity is often embedded in other activities such as counting, locating, building, cooking, designing, and playing, and this idea raised questions about whether traditional western subjects like mathematics are the best way to organize learning and knowledge for non-western cultures.

Alternative ways of envisaging learning and knowledge also exist in the west, for example Hart's view (in 11.6), and that of feminists (in 7.4); however, different traditions are sometimes seen as inferior, and in English-speaking countries there is often an undue emphasis on the Anglo-American cause/effect view of things. In my experience in developing countries there often seems to be little debate on issues after hegemonic opinions from Anglo-America countries had been expressed. In addition, Eastern knowledge often seems to be ignored. As Engler (1984, p 112) wrote regarding Buddhist psychology, talking about the *I*:

... the self, as it has been understood from the perspective of newer developments in ego, object relations and self-psychology, is now seen to be exactly what Buddhist



psychology and practice have always said it was: namely, a mental representation or construct, not an entity.

I knew that the knowledge of indigenous people such as Maori, Australian aboriginals, Pacific Islanders, First Nation Americans, and others, had often not been valued by the dominant western culture, and found that it was not always valued by the indigenous people themselves after they had been influenced by the west—the exception being fields such as ethno-medicine where westerners see potentially large financial gains.

One major influence on ways of thinking seemed to be language. Looking at some differences between languages in the East and West highlights this. As Kelman (1958, pp. 75–76) said:

Our language is noun-oriented. We make propositions about things. Languages which are verb-oriented make propositions about events. They are more suitable for communicating immediacies. ... Process languages facilitate experiencing. ...

And, as Fairhall (ca. 2001) told me, Maori traditionally seemed to use numbers as verbs rather than as adjectives or nouns. In addition to this, many Polynesian languages were oral rather than written languages and used the passive voice more than the active one, thus, when mathematics is translated from English into these languages not only are translations required for the technical words, but care needs to be taken so that the dominant grammar of the languages is not disrupted.

Accepting and honouring the knowledge traditions and languages of different cultures may help us better understand ourselves and our view of knowledge, and the international students who come to our education systems from other traditions.

Even in cultures that share traditional subjects variation occurs. For example with logic, in western mathematics logic is emphasised—something is either *this* or *that*. Other forms of logic argue for *this* or *that* or *both this and that*, or *neither this nor that* or *this and that and more* and even *this and not this at the same time*. This raises the questions, what is the logic system of a particular culture, can alternative logic systems be used within mathematics, and, how important is logic in mathematics? While logic is a focus in western mathematics some cultures emphasize utility, and others its recreational aspects, and this raises issues for curriculum emphasis.

It is not only what is to be taught that varies across cultures, but also how it is taught (Begg 2006a). Traditionally western teachers relied on teacher *talk and chalk*, on students listening then doing drill problems from which it was assumed they would learn the concepts and procedures that had been taught. The aim of drill and practice was different from that in the east where drill is assumed to be for understanding and not merely for repetition. Western teaching strategies seemed problematic in some cultures. Questioning of and discussion with the teacher are not appropriate in some cultures because of students' respect for authority and the custom of not speaking to elders. Responding verbally to a question in front of a whole class may make a student uncomfortable because of the *shame* they would feel if wrong and the humiliation of being separated from their community. Contextual problems are not always appropriate, for example the context of navigation at sea would be unfamiliar to learners in an inland mountain village. For numerous indigenous groups considerable emphasis is put on learning by observing and imitating, while in the west this seems to occur in home situations but is rarely encouraged in schools.

Reagan (2000, pp. 206–208) highlighted issues that vary across cultures including:

- the role of informal education, parents, and the community,
- the place of values, morality and the meaning of life in education, and
- the relative importance of economic, vocational and spiritual aims.

All these issues suggest there are many ways to help people learn and we have much to learn from practices in other cultures. Although we live in a western-dominated world, I believe that what is taught to other cultures and how it is taught should depend on the educational aims of that culture—not merely what government officials of that country think, or what overseas *experts* suggest, but what the people of the culture want. I know that finding what people want is difficult; their views may be diverse and tinged by their schooling, which was often western.

## 11.8 Coming to know

My ideas about teaching and learning have changed over my lifetime. As a young child at home and outside school I learnt by imitation, in my early schooling (4.3 & 4.4) direct instruction prevailed, as a teacher behaviourist ideas were to the fore (4.6, 5.2, 5.3, 5.4) with some early notions of constructivism (7.1). In my last teaching position in a school I saw that the critical factor for learning was the learner (5.5); and that while teachers facilitate learning they are neither a necessary nor sufficient condition to ensure learning occurs. After that my thinking moved to radical constructivism and later as I thought and read more about other ways of knowing, I moved towards enactivism (8.3). But, there is much I still need to clarify about this, especially with respect to teaching which I believe is the aspect that teachers want.

Coming to know is complex and messy. The metaphor of building complex, unique, and never complete schemas fits well. I assume that much learning and knowing is not at the conscious level. I see coming to know as the responsibility of learners. I see teachers as learning facilitators who organize learning activities to help students come to know. I believe that many good teaching strategies exist though some are culturally dependent. I see rich learning tasks/activities (table 11a) that fit the criteria of Ahmed (1987) and Cox (1998) as being most useful.

Table 11a: *Criteria for rich learning tasks/activities*  
(modified from Ahmed 1987 & Cox 1998)

**Rich learning activities should:**

- approach the unknown through what is known to the students
- be accessible to all students at the start
- allow further challenges and be extendible
- challenge the better students without overwhelming the weaker ones
- be interesting to the students, and to achieve this, to the teacher
- have an element of surprise
- be enjoyable (that is, engaging)
- should not trivialise the subject
- introduce material within the programme at a time relative to its use
- provide opportunities for constant review
- invite children to make decisions
- involve children in speculating, hypothesis making and testing, proving or explaining, reflecting, interpreting
- not restrict pupils from searching in other directions
- promote discussion and communication
- encourage originality/invention
- encourage ‘what if’ and ‘what if not’ questions
- emphasise key general principles more than technical details
- provide specific illustrations of general principles
- be seen both as an end and as a basis for subsequent work and study
- avoid the temptation to teach too much material

Flewelling (2002) spoke of tasks that support *sense making*, these give

students the opportunity to play the sense-making game and, over time, to learn how to play this game at progressively higher levels. ... (The game) is about using knowledge and experience in integrated, creative, authentic, and purposeful ways to solve problems, conduct inquiries, carry out investigations, and perform experiments. ... (The goal of sense making is) more than coming to understand mathematical concepts and procedures ... (and) it is also about such things as making sense with mathematics, making sense when communicating with others, making sense of situations, (and) making sense of people’s actions and ideas.

Houssart (2004, p 138) used the term *elastic tasks* to emphasize accessibility, and extendibility; while Wigley (1992) emphasized the need to change to a form of teaching involving challenge, time, opportunities for conjecture about methods or results, teachers drawing out students' ideas, strategies that relate to a variety of problems, and identification of what is learnt and how it connects to prior learning.

Accepting these notions about rich activities/tasks I would add that their focus should be on the *big ideas* of a subject and *broad cross-subject themes* rather than on specific outcomes or objectives that derive from teachers analysing a subject (or worse, taking someone else's analysis) into outcomes and focusing their teaching only on these. These outcomes are usually easily measured facts or basic skills and the process and thinking aspects of knowing are too often neglected.

Coming to know always builds on prior knowledge. This is especially important with adults and older learners, as their *schemas* are more robust than those of younger learners as they have stood the test of time. This is relevant when teachers consider a new curriculum, their thinking is always connected to their experience with the previous curriculum, and so changes that do occur in teaching are usually small evolutionary ones rather than major or radical changes—curriculum is a rich learning task, time is needed, but it does fit many of the above criteria.



## Chapter 12 Looking backwards and forwards

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### 12.1 Looking both ways

As I continue *laying down a path in walking* (Varela, Thompson & Rosch, 1991, p 237), my path, in particular concerning curriculum and development, is influenced by my understandings of complexity, living systems, enactivism, and my (octagonal) model for development. Looking backward, developing these understandings was a long and complex learning process. My writing may suggest I know these things, but looking ahead I know my understanding is incomplete and there is more to learn.

As I reflect on this writing I see a possibility that I might be viewed as intense—this is a misconception that needs to be corrected. My path has been interesting and my thinking stimulated by colleagues in NZ and overseas and by students, in particular, graduate students. My thinking deepened as I learnt more over many years. There is a saying that *if one wants to be old and wise then one needs to start off young and foolish*. I know I have been young, but I prefer naïve and brash to foolish; now I see myself as aging and learning, not old nor wise. My life has been relatively easy, full

of fun and quite lightweight, however, in selecting nearly 70 signifying incidents and focussing only on these, my writing may suggest an intensity that is not me.

The saying *build on what the learner already knows* is good advice for teachers. As I look ahead I know that living is learning, that my past influences my future and that my identity is formed by my past. Similarly with curriculum, it is a living system and is influenced by the past and the possibilities that exist for the future.

Within my lifetime I can trace the evolution of curriculum from the *content* metaphor (Cobb 1999). This evolved with direct instruction (chapter 4), was strengthened when behaviourism flourished (4.6 and chapters 5 & 6), was made tentative with constructivism (chapters 7 & 8) but reinforced again with the politics of outcomes-based education. Looking forward I see an increasing acceptance of what Cobb (1999) called the *emergence* metaphor (10.2 & 10.3). *Emergence* is based on complexity, evolutionary learning, systems, and enactivist ideas. The shift is likely to take many years before gaining the support of most teachers and of some politicians.

With complexity and the emergence metaphor both communal and individual learning occur, as Cobb (1999) says, there are

collective practices, ... the taken as shared ways of reasoning, arguing, and using tools that are established by a classroom community ... (and a need) to acknowledge that students participate in any particular practice in a variety of qualitatively different ways.

I see this diversity of *qualitatively different ways* as deserving celebration, and envisage these ways as being used for developing deeper understanding, and influencing students' feelings of confidence and worth, though, as Capra (2002,



p 295) has said, ... *diversity is a strategic advantage only if there is a truly vibrant community, sustained by a web of relationships.*

Whether these *qualitatively different ways* are recognized by teachers, and allowed to contribute to their practices will depend on teachers' mindsets. These will continue to be influenced by curriculum at a number of levels—official documents, textbooks (commercial curricula), the planned and implemented curricula (that in turn are influenced by teachers' experience and professional development) and the assessed curricula. Another influence on recognising and using these ways is whether teachers plan *from* curriculum documents or are into *curriculum anticipating* (Davis 1996).

Looking back I see curriculum and my professional self as coming together; just as living is learning, one is what one enacts. Bowman & Haggerson (1990) identified this and wrote of *curriculum as self* (p 50). I interpret their *self* as referring to students and teachers. Greene (1990), in her comment to Bowman & Haggerson (1990) interpreted *self* as referring to *what is in the making* (p 75) and students and teachers are both in-the-making. Thinking this way fits with systems thinking; it implies that curriculum is more than planning for the classroom, it relates to all aspects of the subject(s) being taught, to the pedagogy used and to the identities of the teacher and the participating students. However, Bowman and Haggerson (1990, p 59) noted, that this does not refer to all students, as

some students do not fully participate in the process for some reason or another. An unfolding, enfolding curriculum requires students to become active agents in their own learning.

I disagree with Bowman and Haggerson, these students are learning, albeit the unintended curriculum, they are still in-the-making.

## **12.2 Revisiting aims**

Since Plato western formal education was linked with schooling. The aim in his time was to train future leaders to preserve their *ideal* society. Thus, education preserved power and privilege for the ruling/upper class. Academic subjects including mathematics made up the curriculum—practical knowledge was for the lower classes. Academic schooling for the upper class has continued and influences schools today. It is evident in curricula where aims focus on national economic growth rather than social or personal growth. It concerned writers such as Foucault (1980) who wrote about power structures (upper classes, church, and business) and Freire (1972) who wrote of alternatives that questioned power and privilege.

Egan (1996) put a different slant on educational aims. He argued that we have three aims, each of which is incompatible with the other two. These are:

- 1 to make good citizens and inculcate socially relevant skills and values
- 2 to master certain bodies of knowledge
- 3 to fulfil each student's unique potential

Egan saw these as causing clashes in terms of curriculum decisions and teaching methods. He envisaged a way forward as learning to use particular *intellectual tools* to generate successive understandings, namely:

- somatic (pre language, bodily knowledge)
- mythic (language, myth, abstraction, metaphor, narrative, and images)
- romantic (extremes of experience, transcendence, human emotion)
- philosophic (generality, social agency, certainty, flexibility)
- ironic (irony, beyond language, self-awareness)

I agree with Egan that we hold these three educational aims, indeed they fit with Munro's (1969) social, cognitive and personal aims; and the intellectual tools Egan wrote about are useful. However, I am more optimistic than Egan. I see his three aims as compatible, though finding a way forward might be difficult. One difficulty may be starting where teachers are as some may still reflect a naivety similar to mine in my first ten years of teaching.

Initially while teaching I thought about the topics I taught but not about why they should be taught. I had not thought much about the purpose or aims of education, it was taken for granted; yet at the same time I was concerned about existence and the meaning of life. In the seventies (5.4 & 5.5) my thinking was influenced by the teacher association report (Munro 1969); the suggested aims put more meaning into my work and began to influence my thinking about my role and responsibilities as a teacher. In the 80s as a curriculum officer (chapter 7) I continued to think about educational aims, though while these underpinned my work they were rarely explicit.

As emerged in chapters 8 to 11, my current view of schooling/curriculum aims is that they are nested at three levels, the purpose of education, the aims of education and subject specific aims. When I re-read Krishnamurti (1956, p. 9) I was reminded of a fundamental question that I have often pondered. He wrote that people in India, America, Europe and Australia, especially in colleges and universities, seem to be turning out people

whose chief interest is to find security, to become somebody important, or to have a good time with as little thought as possible. (He went on to ask, p. 11) What is the significance of life? (and) ... of what value is our education if we never discover it?

With the notion from Maturana and Varela (1987) that *living is learning*, Krishnamurti's question, about the significance of life, becomes particularly important. In addressing this my mind had turned to notions of self-knowledge and the development of awareness because I saw this as a part of learning that tends to be neglected. Another response to the question was implied by Buddhist philosophy—to do as little harm as possible, and to leave no footprint. This for me implied love and acceptance of others and of the world. While ideas of love are not usually associated with educational aims or curriculum they resonate for me with the statement of Maturana and Varela (1987, p 246):

Biology also shows us that we can expand our cognitive domain. This arises through a novel experience brought forth through reasoning, through the encounter with a stranger, or, more directly, through the expression of a biological interpersonal congruence that lets us *see* the other person and open up from him room for existence beside us. This act is called *love*, or, if we prefer a milder expression, the acceptance of the other person beside us in our daily living. This is the biological foundation of social phenomena; without love, without acceptance of others living beside us, there is no social process, and therefore, no humanness.

The notion of love, specifically love-of-self and love-of-others fits with the second and third aims from Munro (1969, p 1), *self-respect, and a concern for others*. I believe that teachers address these three aims though they may put different emphasis on the cognitive, personal and social aspects and the word love is rarely used. For me, as discussed in 5.3, my thinking about these aims has changed as I interpreted each more broadly and I found myself paying more attention to the students than to my subject.

I believe the basic aim for studying different subjects is to help learners develop ways of making sense of their worlds. This implies that a number of subjects should be studied and that no subject should take precedence over others. Within each

subject there are three interrelated foci— knowing, doing and thinking. The main change over my lifetime in my thinking about mathematics has been to put more emphasis on *doing* rather than the *knowing*, and more recently, on *thinking*.

However, it dismays me when subject curriculum developers glibly talk about thinking without discussing the contribution to it of each subject.

More important for me than the aims that emerge and change over time is the aims development process. This is policy development at the school level in my model (10.2)—schools developing their philosophy, teachers thinking about aims, and finding common ground between personal, school, community and curriculum aims. However, finding common ground is not a simple task, as Greene (1995, p3) said:

Now, with so many traditional narratives being rejected or disrupted, with so many new and contesting versions of what our common world should be, we cannot assume there is any longer a consensus about what is valuable and useful and what ought to be taught, despite all the official definitions of necessary outcomes and desired goals.

My final concern about aims is that they appear in the preamble of curriculum documents (including teachers guides and textbooks) and in school philosophies but are not embedded within subject details nor the mindsets of teachers. In my experience teachers read curriculum preamble once then only subconsciously consider aims while they consciously use content details in their lesson planning.

### **12.3 Rethinking curriculum**

My thinking about curriculum has changed over the years. As a learner and a young teacher (4, 5.2 & 5.3) I assumed it was a list of topics for a course (usually called a syllabus, course outline, or examination prescription rather than a curriculum). When

curriculum documents were written in a form that focussed on behavioural or assessment objectives it seemed the list of topics was simply more detailed.

In the writing stage of my career (chapter 6) the textbook became my curriculum focus. I knew that mathematics teachers in particular relied heavily on texts, I was aware that for many teachers in the USA that the de facto curriculum is the textbook, and I knew that in NZ the text is not the official curriculum but it has an influence in mediating between the official and the planned and taught curricula. While writing textbooks my co-authors and I became increasingly aware of the need to broaden the teaching-learning approaches, that is, to concentrate on pedagogy as well as content and attempted to incorporate this in texts we wrote (Begg, Mackintosh & Thomson 1974–78).

In CDD (chapter 7) my thinking moved to the curriculum definition, *all planning for the classroom*. This implied including more than content and in the draft syllabus produced from the project that I chaired *each module had: aims; context; content; learning experiences; assessment objectives; options; [and] pre-requisites (where relevant)* (Department of Education 1989, p 7). In developing this draft we assumed that teachers would design mathematics courses within a broad framework but with flexibility to meet the needs of their students, that they would plan teaching progressions for their courses and that assessment objectives would be broad ones that emphasized the *big ideas* within modules rather than behavioural objectives.

During the next stage of my career, teaching mathematics education to graduate students, constructivist and then enactivist learning theories were coming to the forefront of my attention. These theories had implications for curriculum. Firstly coming to know was envisaged as an active process in contrast to the passive reception of knowledge and this implied a need for the type of learning activities that foster active learning.

Secondly, constructivism and enactivism implied a complex process involving building knowledge schemas with students building unique schemas in their own ways, at their own speeds. The notion of a *normal* progression of learning no longer seemed reasonable; I began to see progressions as self-fulfilling prophecies.

Thirdly, I began to appreciate phrases such as curriculum-in-the-making, curriculum-in-the-moment, and curriculum anticipation. I realized that the planning that teachers do, including reflecting on earlier experiences teaching a topic, can never result in what will happen in the classroom but only what might happen. Bruner, (1996, p 84) has said that *you cannot teacher-proof a curriculum any more than you can parent-proof a family* and I would extend this by adding *and you cannot student-proof a lesson plan*.

Fourthly, I had noticed that some teachers when teaching were *role-playing* rather than *being themselves* and were often stressed. With notions of emergence I began to see a closer link between my developing identity and my work and I came to understand the difficulty that others have as they *act as teachers*. Teaching and

learning are always linked with curriculum in the broad sense and I began to see the curriculum as influencing the identity of teachers and students while at the same time they influenced curriculum. For me this fitted with two ideas—*to live is to know*, and, *we are what we live*.

More recently, in semi-retirement, doing consultancy work for the NZ curriculum, I found that the new curriculum is officially about more than subject knowledge and suitable pedagogy. In the current review there has been considerable debate about principles, values, competencies and pedagogy. However, in the usual way these merely form the preamble to the curriculum. From my experience such a structure was problematic. In reviewing the draft I reminded the writers (Begg 2006b) that most teachers glance briefly at a framework document and a preamble of subject curricula then focus almost exclusively on content topics. I went on to say that while there is a need for an explanatory preamble, the only way to embed principles, values, competencies and pedagogy into curriculum is to design a structure that integrates these within the subject content details. I suggested that within each learning area (subject) there is a need for statements about the following:

- principles to be emphasised and the topics this might be done with
- values that might be developed with particular topics
- aspects of competencies that might be addressed within particular topics
- appropriate pedagogical approaches.

I felt a little guilty not requesting more parallel statements to address the emotional, spiritual, personal and social dimensions, but felt the need to redesign the curriculum structure within the parameters the committee had set as their priority came first.



Many teachers, in particular high school ones, and even more particularly mathematics ones, are well educated in terms of their subject but less well in pedagogy. Hence in planning there may be less need for subject content guidance and more for pedagogical guidance. With primary teachers the reverse is possibly true, though with them the pedagogy is often of a general nature rather than subject-specific. It may be that teacher guides are the more appropriate curriculum documents for pedagogical details, but I see it as desirable for an official curriculum to set the scene for such complex and multi-dimensional planning.

As with pedagogy, the same is true of the desired competencies. In NZ's current review one competency is thinking. Teachers assume that students think but have little awareness of the specific thinking skills required or developed within a subject. While some thinking skills (critical, creative, and metacognitive) are important in all subjects, the balance between these may differ and each subject requires specific thinking skills which need to be taught. Working at the OU I came to see these skills as more important than the content topics and in mathematics they include:

- generalizing and specialising
- conjecturing and verifying
- imaging and expressing (visualizing)
- changing representations

Unfortunately, in most mathematics classes these are not emphasized.

I am concerned that if a new curriculum makes no effort to integrate the multiple dimensions (content, processes, thinking, aims, principles, competencies, values, and

pedagogy [including assessment]) then it will be a *no change* curriculum, a *shifting of the deck chairs on the Titanic*. No doubt many teachers will be comfortable with no change, feeling that they have experienced too much change in the recent past. They may think that prescribed changes do not recognize the complexity of their work. They appreciate the risk involved with change and are neither convinced by the need for change nor have they been involved in the process. Thus, they are likely to continue to focus on the subject dimension of curriculum (in particular, subject and assessment outcomes) because that is how the current curriculum is structured and slowly assimilate some aspects of the new rather than accommodate all of it.

## **12.4 Empowering teachers and learners**

I recall at university asking fellow hostel students what the highlight of their schooling was. Nobody mentioned passing examinations or wonderful teachers, perhaps these were taken for granted. They all talked about extra-curricula activities—the football trip, the weekend rowing regatta, cultural clubs, the school play or operetta. There was a sense of novelty about these activities but there seemed to me to be more. These were activities that students opted into and made a commitment to these along with fellow students who were interested. With these activities the whole person was involved cognitively, socially, emotionally and physically, and the same cannot be said of most mathematics lessons. The value placed on these types of activities was further confirmed when as a teacher I was involved with students in many extra-curricula activities. The word *extra* in the phrase concerns me and I wonder if it should be replaced by *real*.

Later, when teaching at AMC (5.5) I observed the development of fellow teachers and students, all thrived on the notion of choice and involvement in decision making and this fitted with my reading of Rogers (1969, 1978, 1980). Then, when doing research (8.3, & Begg 1994a) one of the papers that influenced the direction of my research was by Robinson (1989), it related to empowerment and professional development.

In thinking about empowerment, I know I have been lucky. My upbringing and many of the opportunities I had at school were empowering, and throughout my career I have felt empowered or simply confident enough to not allow others to control my life. I have always attempted to not control others, and to be empowering within my family, with students, and with colleagues. However, I recognise that many people have neither felt empowered in their lives nor seized empowering opportunities. From a curriculum perspective I see empowerment starting when education starts.

This mindset emerged for me and I am concerned that a curriculum document should have the aim of empowering teachers and students. My colleague Gunn (2001, p 97) wrote from her enactivist perspective,

We can't cause others to learn or influence 'what' they learn. ... we can act as triggers but an individual's structure determines their knowing and doing.

It seems to me that empowerment is not something we can choose to do but is something we must do to provide opportunities for all students to be *triggered*. But, how best can a curriculum be structured to empower teachers and students?

Firstly, the size of a curriculum document seems to matter. In my experience, the more detailed, the more intricate, and the more specific a curriculum document is the less teachers rely on their professionalism. A large or overfull curriculum often contains no mention of what is less important and could be omitted. Secondly, assessment matters. If specific objectives are all to be assessed, in particular by external means, then teachers, not wanting to disadvantage their students, attempt to teach all the curriculum in ways that are intended to result in success, but may not be concerned with analysis or understanding.

A concern about connectedness (between concepts within a topic; between topics; between subjects; with school and life; and between individuals, their communities, and the environment) assumes a connected/ecological approach to education. I saw connectedness relating to empowerment and student responsibility. Recently, reading Hamilton (2005) I noted that she identified a similar relationship. She convincingly argued for the interdependence of connectedness with successful learning based on a pedagogy that connects and empowers. She discussed school power, teacher power, and student empowerment. Student empowerment for her implied that students had opportunities to choose topics or at least subtopics, approaches to these topics, and ways of working—but some teachers found this threatening. Hamilton (2005, p. 25) talks of disconnection and alienation and claims the risk factors include:

- content that is not stimulating for students and is unrelated to their worlds
- small range of choice
- lack of student participation in curriculum decisions about content, process and assessment
- passive teaching-learning strategies
- minimal interaction with teachers and peers
- lack of cooperative activity based and independent learning
- competitive exam dominated assessment
- one off rather than progressive assessment

These factors have implications for connectedness and empowerment if one assumes that these are curriculum goals. I would like to see a curriculum that takes student responsibility for their own learning seriously, that suggests ways that teachers might empower students as well as being empowered themselves. I see the need for such empowerment to be from an early age so that responsibility is developed. I accept that a significant influence on empowerment lies outside schools, but this for me means that even more needs to be done in schools to ensure all students experience empowerment. However, some politicians in the Platonic tradition of preserving the status quo and passing on their own social values could well not agree with me.

The curriculum is for the students, and as Hamilton (2005) suggests, it is important that students be empowered. This is unlikely to occur during a review of a regional curriculum so curriculum design should foster the notion of student voices being listened to at classroom level. By listening I mean hermeneutic rather than evaluative or interpretive listening, as Davis (1996, p 53) has said:

... evaluative listening is an uncritical *taking in* of information that is *out there*, interpretive listening involves an awareness that one is *projecting onto* one's understandings particular biases that are *in here*, and hermeneutic listening is a *participation in* the unfolding of possibilities *through collective action*.

## 12.5 Assessing and curriculum

Black (1998) suggests that high-stakes testing constrains teachers and pupils to align learning to meet demands of tests; and the Cockcroft report (1982, p 159) talks of assessment so that students can *demonstrate what they do know rather than what they do not know*. Both these suggest we need to change our attitude to assessment.

From my experience gained while at university (chapter 8 & 10.4) I believe that:

- formative (including diagnostic) assessment is part of good teaching and Davis's hermeneutic listening is one successful way to carry this out
- summative assessment for evaluation purposes, reporting, and qualifications is overemphasized by policies designed as if students were products from a factory built to the same specification, the emphasis reflects the simplistic view that everything can be measured, and the management/accountability attitude to education, and does not acknowledge that a number of countries have survived perfectly well for long periods without external qualifications based on examinations (e.g., The Netherlands and Sweden, 9.2)
- reliable data for measurement of standards or system-wide quality control can be easily and cheaply obtained by research using light sampling techniques
- self and peer assessment is not given adequate emphasis yet is one of the self-management techniques that learners need to learn if they are to take control of their own learning and become life-long learners

From my perspective the emphasis currently put on assessment in NZ, in countries with outcomes-based curricula, and implied by curricula that are structured round assessment or achievement objectives, results in assessment undermining some of the basic curriculum intentions. I would prefer assessment to be subsumed by pedagogy and for the emphasis to be on informal formative assessment and self and peer-assessment. This would address concerns about the lack of connectedness in education that contributes to the atomization of knowledge with the most extreme cause of this being competency-based or outcomes education. It also fits with and

goes further than the change that Shepard (2000, p 31) hoped for when commenting about the situation in the USA:

... assessment in classrooms must also be changed fundamentally so that it is used to help students learn and to improve instruction rather than being used only to rank students or to certify the end products of learning. The nearly exclusive normative use of tests in the U.S. to compare students to one another and to determine life chances is the key culprit in developing classroom cultures dominated by an exchange value of learning, where students perform to please the teacher or to get good grades rather than to pursue a compelling purpose. By contrast, in classrooms where participation in learning is motivated by its use value, students and teachers would have a shared understanding that finding out what makes sense and what doesn't is a joint and worthwhile project, essential to taking the next steps in learning. To serve this end, more specific principles of classroom assessment require that expectations and intermediate steps for improvement be made visible to students and that students be actively involved in evaluating their own work.

Such a shift in assessment would focus on what students know rather than on specific outcomes that some have not yet understood and that others knew before the series of lessons began. In addition, it values what is already known and seeks to find what students believe they need to know. This focus fits with the *post-box* approach developed by Biddulph (Biddulph & Osborne 1984)—the teacher asks students what they know about a topic and what they want to know, the students anonymously write and then *post* their reply in the class post box, the teacher plans the next lessons by organizing numerous activities based on the responses, next day the children form groups based on the activities that they choose.

Bowman & Haggerson (1990, p 59), wrote about students not fully participating in the curriculum, suggesting:

Some hide behind the expression, "Just tell me what I have to learn for the test." Others say, "I know what I believe about the teaching/learning process. Don't expect me to change my views." It appears, though, that these students are afraid to take the risk of reflecting on self as it relates to the curriculum.

Such comments are familiar to many of us, they reflect what students have *learnt* and for me they emphasize the urgent need to change schooling.

I believe that summative assessment has become important because of what Langer (2005) calls *the tyranny of evaluation* (pp. 41–73). She said that *it is important that we can be discriminating without being evaluative* (p 58). Similarly Reagen (2000) wrote of the concern with formal certification and degrees rather than with competence, and Jacobs (2005, pp. 44–63) discussed credentialing versus education.

Some teachers argue that assessment provides motivation, but learning should be for the sake of and for the love of learning. That is intrinsic motivation, not for extrinsic motivation; within the context of mathematics education Firsov (1996) wrote about the importance of motivation and said that the most motivating thing is success, and the most de-motivating is failure which too often accompanies high stakes assessment.

## **12.6 Developing complex curricula**

I have discussed multiple levels of complexity that lie within my concept of curriculum. While subjects include knowing, doing and thinking much more is and can be learnt in every classroom—for example, language, belonging, peace and negotiation, justice and punishment, compliance or empowerment, democracy and power, ethics, cooperation or competition, and the importance of emotion and intuition as well as the rational. Schools influence students' values and attitudes and every teacher, by the way they organise their class and teach, teach values. However,



teachers, especially during the first one or two years of their careers, have often not reflected on this aspect of their teaching or thought about pedagogy that might be more appropriate when developing these aspects of curriculum beyond the subject.

As teachers we base our practice on our previous experience, and cannot change everything at once. In my earlier research (Begg 1994a) I found that if teachers did not support professional change then they relied on their prior experience. In terms of curriculum change I have seen that if teachers are not supported by development opportunities and curriculum documents then they revert to previous documents or familiar resources including textbooks. Gunn (2003) identified one of the main problems when she wrote:

... many of the dissatisfactions with 'curriculum' that educators are currently experiencing stem from trying to (make meaning of) understand what is experienced essentially as an evolutionary process (i.e. knowing, coming to know) with the inherent rigidity of the mental-rational mind. To understand a fluid reality in all its complexity, one needs a fluid perspective and this is what I believe an ecological/evolutionary perspective offers.

My octagonal model of influences on development (10.2) includes the main influences on curriculum within such a fluid reality, but these cannot be controlled in an orderly way and the impact of each is unpredictable. The process is a messy one, and it occurs over time, both immediate and long-term, and at multiple levels from international to personal. Difficulties obviously exist with communication across levels, in particular national levels listening to individual teachers, but perhaps one way to reduce this problem is a shorter curriculum that allows individual teachers more say at least in terms of details.

Other models of curriculum also imply complexity. Wragg (1997) described a multi-dimensional view of curriculum with the principal dimensions being subjects (including mathematics), cross-curricula themes (such as aesthetics, citizenship, language, thought, imagination, personal, political, and numeracy), and the forms of teaching and learning which are employed (such as telling, discovering, ...).

Doll (1993) wrote of a *curriculum matrix based on the four R's—richness, recursion, relations, and rigor* (p 161) and that such a matrix (p 162)

has no beginning or ending; it does have boundaries and it has points of intersection or foci. So, too, a curriculum modeled on a matrix is nonlinear and nonsequential but bounded and filled with interesting foci and related webs of meaning.

For me these models imply complexity but are static. I envisage curriculum as in-the-making, evolving and being influenced by students as well as teachers, and by parents, policy makers, and others. I envisage community influence as including cycles of consultation—a two-way process where aims and community aspirations and strategies to achieve these are discussed. In considering ideal curricula for different cultures such consultation processes are likely to be extended ones and power differences between teachers and community will be critical.

Student voices need to be heard. I accept that at regional level it is often assumed that students do not have the experience to contribute, though personally I dispute this and see a need to include them within community/parent consultation. At classroom level numerous possibilities exist for students, these include:

- *switching-off* in class
- moving within the space the teacher provides, for example
  - o using such approaches as the post-box approach (12.5)
  - o questioning (see 5.5)
- having more choice within curriculum (5.5)
- having teachers plan lessons based on *curriculum anticipation* (Davis 1996)

The development process at the *official* level also evolves. The traditional RDD model (research-development-dissemination) was never linear, it was cyclic because each few years when a curriculum was reviewed the starting point was always what had come before. When thinking cynically about the RDD model I have called it the PHUT model (politics-hunches-underfunding-totalitarianism), but it has the same property, it is a development (though sometimes misguided) based on earlier documents and situations. I believe that development depends on what has occurred before and this implies that one cannot implement a completely different model for curriculum development and use it, as the model would always be interpreted with the memories of past processes and this would influence the way it was construed.

Thus, while I, like others (e.g., Print 1987, p 25) see an objectives model as flawed, and while I have serious concerns about the RDD model for curriculum development, changes are likely to be evolutionary rather than revolutionary and this means they will evolve subject to the political and educational environments in which they exist. In the sixties the *new math* movement was seen as revolutionary, suggesting that curriculum revolution is possible, but I would refute this. The *new*

*math* directed teachers to change *what* they taught, but it did not direct them in terms of *how* they taught it, and therefore it did not threaten their *identity* as teachers.

When writing about teachers' professional development programmes and systems thinking, Hoban (2002, p 68) said:

First, the word 'learning' is preferred to 'development' because learning is essentially non-linear, whereas 'development' suggests a linear step-by-step process. Second, the term 'system' is preferred to 'programme' because a system implies a combination of conditions that interrelate to support learning, whereas 'programme' implies a prescriptive plan of events.

The same notion is applicable to curriculum development at national or school level though the words *curriculum learning* or *system learning* are possibly too broad and would be misunderstood. For me the notion of a curriculum system learning in a complex way fits with Davis's phrase *curriculum anticipating*, and perhaps this is a better term than curriculum development.

An important issue is the purpose and intended use of a curriculum document. Paradoxically it is both a statement of government policy and intended to assist teachers with planning. This raises a status issue, is it prescriptive or for guidance? And further raises the question, should it be a top-down or bottom-up document? That is, should government or teachers be in charge of the curriculum and its development? In terms of teacher planning, should the document be the basis for planning a programme or a checklist to be used after teaching topics (to audit a programme)? Taking a complex view of these three questions I would respond with yes six times. These are not dichotomies; they are not mutually exclusive options. Even amongst teachers curriculum documents are interpreted differently regardless of educational authorities' intentions.

How a complex curriculum might ideally be developed is not clear. Whether acknowledged or not, the process is evolutionary, development will vary from one educational environment to another. The components from the model I have suggested (10.2) will have different weightings in different situations. The diversity of curricula that are likely to result will provide further richness to influence other developments. And this process will vary not only from region to region, but also as curriculum is developed and interpreted at local, school and teacher level.

## **12.7 Structuring curriculum**

The complexity of a curriculum with some of the following:

aims, principles, goals competencies, values, pedagogy;

content, processes and thinking within each subject;

main strands and topics within each subject; and

some detail of suitable learning tasks (and possibly assessment tasks);

presents a difficult structuring challenge. In the 1980s most mathematics curricula focused on content, more recently the doing aspect (the mathematical processes) has been emphasized. New priorities are emerging for teachers to attend to—within each subject there is a thinking aspect, and beyond subjects there are the underpinning but important (perhaps even more important than subject knowledge) general competencies that teachers need to attend to.

There seems to me to be no clear way forward with respect to how a curriculum might be structured to ensure that all these aspects are adequately considered; and teachers cannot be expected to attend to everything at once. This suggests that in new

documents the particular aspects that are thought to need more consideration need to be emphasized. Perhaps Egan (1996) is correct with his emphasis on learning to use particular intellectual tools to successively generate somatic, mythic, romantic, philosophic and ironic understandings. Alternatively the criteria developed by Ahmed (1987) and Cox (1998) for rich learning activities might help. In mathematics in particular, Mason's notion that *a lesson without the opportunity to generalize is not a lesson in mathematics* might be a good place to start.

With no one right way ahead I hope that teachers will try alternatives. Starting with curriculum documents and supporting resources such as teacher guides, and associated professional development, they might focus over time on any one way forward, and take into consideration different approaches that provide opportunities to also focus on the other desired aspects of the curriculum. Some of the starting points are likely to be sourced from textbooks and other resources, but I would hope that the text book does not become the de facto curriculum as it has in the past; because, while authors interpret official curriculum documents they are not able to write for all students in every school, they often focus only on the subject aspects of curriculum, and are usually under some pressure to be conservative in their approach to ensure sales.

In the current round of curriculum development in NZ, a concise curriculum document is planned. From discussions with overseas colleagues it appears that this is also a trend in numerous other countries. The move could be interpreted as cost-cutting by government, or as a desire to allow teachers to make more professional

decisions. Within this scenario the development of a detailed curriculum for day-to-day planning becomes the responsibility of the school. In this situation I would hope that team leaders in school-based development, which I assume will be an ongoing and evolutionary process, will discuss and focus on the range of issues that are relevant for teachers. This is likely to require considerable support as many NZ teachers in the past few years have become reliant on the *script* of curriculum, numeracy projects, textbooks and assessment.

The structuring of curriculum is not simply about how to design an official curriculum document. Curriculum is a process that involves planning and anticipating what is likely to occur in classes. To do this I see a need for discussion about new aspects of curriculum that are to be emphasised. For example, with the current emphasis on thinking as an aim or competency, teachers need to discuss the aspects of thinking their teaching might contribute to and the specific subject aspects that need to be emphasised.

Finally, there is no right way to structure an official curriculum document, a school scheme, or a lesson plan. Learning and teaching are complex and simple solutions do not exist. However, priorities do exist and individual teachers and school teams need to consider these priorities in relation to the students in their care.

## **12.8 Emerging possibilities**

At the end of this study I have more questions than solutions. Throughout life my view of curriculum has changed considerably and I believe that this happens for

many in education. This diversity of viewpoints reflects the complexity implied by systems thinking about curriculum. The diversity may sometimes appear frustrating, but it is part of the evolutionary process, and for me it suggests that curriculum is alive and well and able to respond to emerging needs.

I see a need for research and reflection with alternative possibilities that emerge, but I envisage this as teacher research rather than academic research— exploratory studies or action research involving cycles of further change. Ideally such research should be followed by discussion (teacher meetings and conferences) to help develop a *participatory* culture of teachers involved in curriculum exploration. I look forward to seeing schools and teachers taking responsibility for educational development.

The modelling of curriculum alternatives, the taking on of new roles as teachers and the enhancement of communication and collaboration with others during the sharing process are three aspects of development that will reform our educational system more than policy changes from government. I see my work in an alternative school (5.5) and working anarchically in CDD (7.5) as being what every teacher needs to do—buck the system, reclaim professionalism, and teach from one's heart and mind.

I am convinced that curriculum is more than a product. Grundy (1987) suggests it is *praxis*, and Young (1998) sees *curriculum as practice* (p 27). For me curriculum is a process involving planning, anticipating, responding, and modifying within practice; it is a verb rather than a noun. With such a notion documents are still needed, but they are only part of the view of curriculum that is emerging for many.



Curriculum development is evolutionary rather than revolutionary, but within complexity, points of bifurcation occur, and sometimes changes can be dramatic. Within the *development* process the question *what is the role of the developer?* becomes *how might we all influence development?*

I would personally like to see curriculum move beyond the intellectual and physical dimensions involving thought and action; firstly to take cognisance of the emotional and embodied knowing of feelings, intuition, and unconscious or subconscious bodily knowing; and further to recognizing the spiritual and holistic dimensions of knowing that I see as involving awareness or mindfulness and an increasing commitment to all. Seeing mathematics as a human endeavour bringing together mathematics, the aims of education, and working towards a better future as described by D'Ambrosio (2006) in his outline of the ideas behind ethnomathematics assure me that I am not alone in my hopes. In saying this I do not expect that everyone will share my dream, but I hope that all teachers have dreams and strive for them.

This study is autobiographical, but my life is not yet over. I am and expect to continue to be involved with curriculum for some time. No doubt, with further reflection, more reading, and stimulation from conference participation, my views will evolve further. The final chapter of a study of this form is usually a conclusion but this study is an *unfolding story of my journey with curriculum*, while I may have laid down some of this path while walking, the path continues to be laid down and walked upon by myself and others. In acknowledging this, many possibilities continue to emerge and I am looking forward to considering some of them.



## Bibliography

- Abram D (1996) *The spell of the sensuous: Perception and language in a more than human world*, New York: Pantheon Books
- Ahmed A (1987) *Better mathematics: a curriculum development study based on the low attainers in mathematics project*, London: Her Majesty's Stationery Office
- Alexander C, Ishikawa S, & Silverstein M, with Jacobson M, Fiksdahl-King I, & Angel S (1977) *A pattern language: towns, buildings, construction*, New York: Oxford University Press
- Ashton-Warner S (1963) *Teacher*, New York: Simon & Schuster
- Ashton-Warner S (1972) *Teacher in America*, USA (1974 edition, London: Cassell)
- Atkinson T & Claxton G (2000) *The intuitive practitioner: on the value of not always knowing what one is doing*, Buckingham/Philadelphia: Open University Press
- Australian Education Council (1991) *A national statement on mathematics for Australian schools*, Australian Education Council
- Ausubel D (1978) In defense of advance organizers: a reply to the critics. *Review of Educational Research*, 48, pp. 251–7
- Ausubel D & Robinson F (1969) *School learning: an introduction to educational psychology*, New York: Holt, Rhinehart & Winston (Cited in Mason & Johnston-Wilder, 2004, pp. 152–153)
- Baker R & Begg A (2003) Change in the school curriculum: looking to the future. In: Keeves J & Watanabe R (Eds) *International Handbook of Educational Research in the Asia-Pacific Region*, Dordrecht: Kluwer, Part 1, pp. 539–552
- Batchelor S (1998) *Buddhism without beliefs: a contemporary guide to awakening*, London: Bloomsbury
- Bateson G (1972) *Steps to an ecology of mind*, New York: Ballentine Books
- Bateson G (1979) *Mind and nature: a necessary unity*, New York: E.P. Dutton
- Beeby C (1986) Introduction. In: Renwick W (1986) *Moving targets: six essays on educational policy*, Wellington: New Zealand Council for Educational Research (pp. xi–xlv)
- Begg A (1964) A teaching aid suggestion. *New Zealand Mathematics Magazine*, 1(3)
- Begg A (1975) Mathematical Teaching and School Libraries. *New Zealand Mathematics Magazine*, 12(3)
- Begg A (1980) *Comments on the criteria for evaluation of Auckland Metropolitan College and Four Avenues*. Unpublished paper for evaluation committee

- Begg A (1988) Some changes in statistics teaching and assessment in New Zealand. In: Hawkins A (Ed.) (1990) *Training teachers to teach statistics*, Voorburg: International Statistical Institute (Proceedings of the International Statistical Institute Round Table Conference), Budapest, pp. 39–45
- Begg A (1989) *Mathematics—where is the new syllabus*. Introductory paper at a Teacher-Only Day on ‘Designing courses in secondary schools’, Dunedin Teachers College
- Begg A (1989–1991) (Ed.) *ME/1–6* (Mathematics Education Newsletter)
- Begg A (1990) Mathtrends: developments in NZ high school mathematics. In: *Mathematical turning points—strategies for the 1990s*, (Proceedings of the 13<sup>th</sup> biennial conference of the Australian Association of Mathematics Teachers), Hobart
- Begg A (1990–1999) (Editorial Board) *SAMEpapers 1990–1999* (Science and mathematics education yearbook)
- Begg A (1991) (Ed.) *Mathematika Pasefika—Pre-conference work book* (UNESCO conference) Hamilton, University of Waikato
- Begg A (1991–1999) (Ed.) *ICME(NZ)/1–16* (Mathematics Education Newsletter)
- Begg A (1992a) (Ed.) *Mathematika Pasefika—vocabulary database (version 2.0)* (UNESCO conference) Hamilton, University of Waikato
- Begg A (1992b) (Ed.) *Mathematika Pasefika—conference proceedings* (UNESCO conference) Hamilton, University of Waikato
- Begg A (1992c) Establishing a research agenda for statistics education. In: Periera-Mendoza, Lionel (1993) (Ed.) *Introducing data analysis in the schools: who should teach it and how?* (Proceedings of the International Statistical Institute Roundtable Conference, Lennoxville, Québec), Voorburg: ISI, pp. 212–218
- Begg A (1993a) (Ed.) *MATHSassessment*, (Produced under a Ministry of Education contract, submitted for publication, unpublished)
- Begg A (1993b) *Changes in statistics education*, paper presented at the University of the South Pacific to the Institute of Education and the Fiji Mathematics Assn
- Begg A (1993c) *Future directions: curricula or frameworks?* Paper presented at the conference of the NZ Association for Research in Education, Hamilton
- Begg A (1994a) *Professional development of high school mathematics teachers*. Unpublished DPhil thesis, University of Waikato.
- Begg A (1994b) The mathematics curriculum. In: Neyland J (Ed.) *Mathematics education: a handbook for teachers, Volume 1*, Masterton: Wairarapa Education Resource Centre (and, Reston VA: National Council of Teachers of Mathematics), pp. 193–200.
- Begg A (1994c) *New dimensions for the mathematics curriculum*. Submitted for publication to ‘Mathematics into the 21<sup>st</sup> century project’, not published)
- Begg A (1995) Statistics and the mathematical processes, *Teaching Statistics* 17(2) 40–43
- Begg A (1995b) Popularising mathematics. In: Richards A (Ed.) *Flair*, (Proceedings of the 15<sup>th</sup> Biennial Conference of the Australian Association of Mathematics Teachers), Darwin: AAMT

- Begg A (1995c) A comparative curriculum study. In: Atweh B & Flavell S (Eds) *Galtha*, (Proceedings of the 18<sup>th</sup> Annual Conference of the Mathematics Education Research Group of Australasia), Darwin: MERGA
- Begg A (1995d) The mathematics curriculum: a comparative study. *SAMEpapers* 1995 (pp. 161–185)
- Begg A (1996) Women making a difference! In: Horring J (Ed.) (1997) *Celebrating constructive change—women as an influence in mathematics education*, (Proceedings of Seminar at Auckland University, Mathematics Education Unit), Auckland: Auckland University
- Begg A (1997a) Some emerging influences underpinning assessment in statistics. In: Gal I & Garfield J (Eds) *The assessment challenge in statistics education*, Amsterdam: IOS Press (International Statistical Institute), pp. 17–25
- Begg A (1997b) *Mathematics curriculum development alternatives from federal states*. Unpublished sabbatical report, University of Waikato
- Begg A (1998a) *Mathematics curriculum project: phase 3—report*. Hamilton: Centre for Science, Mathematics and Technology Education Research, University of Waikato
- Begg A (1998b) *Mathematics curricula: some issues*. Seminar presentation at CSMTER, University of Waikato
- Begg A (1998c) Mathematics curriculum and development. In: Kanes C, Goos M, & Warren E (Eds) *Teaching mathematics in new times*, (Proceedings of the 21<sup>st</sup> Annual Conference of the Mathematics Education Research Group of Australasia), Gold Coast: MERGA, Volume 1, pp. 98–105
- Begg A (1999a) *Mathematics curriculum research: ensuring teachers' voices are heard*, Paper presented at the City University of New York (College of Staten Island) and at the biennial conference of the NZ Assn of Mathematics Teachers
- Begg A (1999b) Enactivism and Mathematics Education. In: Truran J & Truran K (Eds) *Making the Difference* (Proceedings of 22<sup>nd</sup> Annual Conference of the Mathematical Education Research Group of Australasia Inc, Adelaide), Sydney: MERGA, 68–75
- Begg A (1999c) *Learning Theories and Mathematics: A, B, C, D, and E*. Paper presented at the biennial conference of the NZ Assn of Mathematics Teachers, Dunedin
- Begg A (2000a) Looking backwards, looking forwards, and looking for direction. In: Bana J & Chapman A (Eds) *Mathematics education beyond 2000*, (Proceedings of 23<sup>rd</sup> Annual Conference of Mathematical Education Research Group of Australasia, Fremantle) Sydney: MERGA, pp. 11–26
- Begg A (2000b) *Course Outline for "Mathematics education: learning theory and curriculum" (0781.532)*. Hamilton: University of Waikato (CSMTER)
- Begg A (2001a) *Researching in education from an enactivist perspective*. A discussion paper from workshop on 'Enactivism as a research methodology', La Trobe University Melbourne

- Begg A (2001b) *Living and Learning Systems*. In: Gunn S & Begg A (Eds) *Mind, body and society: emerging understandings of knowing and learning*. Melbourne: University of Melbourne, Department of Mathematics & Statistics (Discussion papers from a one-day workshop), pp. 29–34
- Begg A (2001c) *Rethinking curriculum and professional development: 'KISS' or 'KICC'?* Seminar discussion paper presented at Monash University, Melbourne
- Begg A (2001d) *Research and development: some issues*. Educational Issues Seminar presented at the Institute for Educational Development of the Aga Khan University, Karachi
- Begg A (2001e) *Values in mathematics education: some ideas for discussion*. An unpublished position paper for discussion, Monash University
- Begg A (2002a) *Reconceptualizing the statistics curriculum: a discussion paper*. Paper presented to the 'Stochastical thinking, learning and teaching discussion group' at the 26<sup>th</sup> Annual Conference of the International Group for the Psychology of Mathematics Education, East Anglia
- Begg A (2002b) *Mathematics in the New Zealand Curriculum: Curriculum concerns*. *New Zealand Mathematics Magazine* 39(2), pp. 3–16
- Begg A (2003a) *Mathematics Curricula*. In: Keeves J & Watanabe R (Eds) *International Handbook of Educational Research in the Asia-Pacific Region*, Dordrecht: Kluwer, Part 1, pp. 597–612
- Begg A (2003b) *More than collaboration: care, concern, connections, and curriculum*. In: Peter-Koop A, Santos-Wagner V, Breen C & Begg A (Eds) *Collaboration in teacher education*, Dordrecht: Kluwer, pp. 253–268
- Begg A (2004a) *Statistics curriculum and development: new ways of working*. Paper presented at the Statistics Roundtable Conference on Curriculum of the International Association for Statistics Education, Lund Sweden
- Begg A (2004b) *Thinking in the mathematics and statistics curriculum*. Paper presented at Seminar for Teachers, Mathematicians and Statisticians, presented at the Institute for Fundamental Studies, Massey University, Palmerston North
- Begg A (2005) (Ed.) *Curriculum matters 2005*, (the first of a planned series of yearbooks), Wellington: NZ Council for Educational Research
- Begg A (2006a) *Ethno-mathematics, ethno-knowledge, and ethno-education*. Paper submitted for presentation at the Third International Conference on Ethnomathematics, Auckland
- Begg A (2006b) *Review of Working Papers, The New Zealand Curriculum, A Consultation Document*. Unpublished review for the NZ Ministry of Education
- Begg A, Bakalevu S, Edwards R, Koloto A, & Sharma S (1996) *Mathematics and culture in Oceania*, Paper presented to Working Group 21: Mathematics and culture, at the 8<sup>th</sup> International Congress on mathematical education, Seville
- Begg A, Davis B, & Bramald R (2003) *Obstacles to the dissemination of mathematics education research*. In: Bishop A J, Clements M A, Keitel C, Kilpatrick J, & Leung F K S (Eds) *Second international handbook of mathematics education*, Dordrecht: Kluwer Academic Publishers (v 2, ch 17, pp. 593–634)

- Begg A, Mackintosh N, & Thomson D (1974a) *Moving with Mathematics 1*. Auckland, Nexus Books (later, Longman Paul)
- Begg A, Mackintosh N, & Thomson D (1974b) *Moving with Mathematics 2*. Auckland, Nexus Books (later, Longman Paul)
- Begg A, Mackintosh N, & Thomson D (1975a) *Working with Mathematics 1*. Auckland, Nexus Books (later, Longman Paul)
- Begg A, Mackintosh N, & Thomson D (1975b) *Moving with Mathematics 3*. Auckland, Nexus Books (later, Longman Paul)
- Begg A, Mackintosh N, & Thomson D (1975c) *Moving with Mathematics 4*. Auckland, Nexus Books (later, Longman Paul)
- Begg A, Mackintosh N, & Thomson D (1976a) *Working with Mathematics 2*. Auckland, Nexus Books (later, Longman Paul)
- Begg A, Mackintosh N, & Thomson D (1976b) *Moving with Mathematics 5*. Auckland, Nexus Books (later, Longman Paul)
- Begg A, Mackintosh N, & Thomson D (1976c) *Moving with Mathematics 6*. Auckland, Nexus Books (later, Longman Paul)
- Begg A, Mackintosh N, & Thomson D (1977) *Advancing with Mathematics 1*. Auckland, Nexus Books (later, Longman Paul)
- Begg A, Mackintosh N, & Thomson D (1978) *Advancing with Mathematics 2*. Auckland, Nexus Books (later, Longman Paul)
- Begg A & Thomson C (1969) *Supplementary Statistics Examples*. Auckland: Auckland Mathematical Association Inc
- Belenky M, Clinchy B, Goldberger N, & Tarule J (1986) *Women's ways of knowing: the development of self, voice and mind*, New York: Basic Books
- Bell B & Gilbert J (1993) Towards a model of teacher development. In: Bell B (Ed.) *I know about LISP but how do I put it into practice?* Hamilton: University of Waikato (Report for Ministry of Education) pp. 365–381
- Bereiter C (2002) *Education and mind in the knowledge age*. Mahwah NJ: Lawrence Erlbaum Associates
- Bishop A (1988) *Mathematical enculturation: a cultural perspective on mathematics education*. Dordrecht: Kluwer Academic Publishers
- Bertalanffy L, von (1940) Der Organismus als physikalisches System betrachtet, *Die Naturwissenschaften*, 28, pp. 521-531. [Reprinted as The Organism considered as a physical system, being chapter 5 of, Bertalanffy L, von (1969) *General System Theory: Foundations, Development, Application* (Revised Edition), New York: George Braziller.] (Cited in Bertalanffy, 1969)
- Bertalanffy L, von (1968) *Orgasmic psychology and systems theory*, Barre MA: Clark University Press with Barre Publishers
- Bertalanffy L, von (1969) *General system theory: foundations, development, applications* (Revised edition). New York: George Braziller
- Biddulph F & Osborne R (1984) *Making sense of our world: an interactive teaching approach*. Hamilton: University of Waikato, Centre for Science and Mathematics Education Research

- Bishop A (1988) Mathematics education in its cultural context, *Educational Studies in Mathematics*, 19(2), pp. 179–191
- Bishop A, Clarkson P, FitzSimons G, & Seah W (2000) Why study values in mathematics education? Contextualising the VAMP project. In: Horng W & Lin F-L (Eds.) *Proceedings of the HPM 2000 International Conference on History in Mathematics Education* (Vol 2, pp. 147 – 154), Taipei: National Taiwan Normal University
- Black P (1998) *Testing: friend or foe? Theory and practice of assessment and testing*. London: Falmer Press
- Blake W (c. 1803) Auguries of innocence. In: Partington A (Ed.) (1992) *The Oxford dictionary of quotations*. Oxford: Oxford University Press
- Blumenfeld-Jones D (1995) Fidelity as a criterion for practicing and evaluating narrative inquiry. In: Hatch J & Wisniewski R (Eds) *Life history and narrative*, London: Falmer Press (pp. 25–35)
- Bowman A & Haggerson N (1990) Empowering educators through the process of enfolding and unfolding curriculum. In: Sears J & Marshall D (Eds) *Teaching and thinking about curriculum: critical inquiries*. New York: Teachers College Press (Chapter 4)
- Brown J, Collins A & Duguid P (1989) Situated cognition and the culture of learning. *Educational Researcher* 18(1), pp. 32–41
- Bruner J (1960) *The process of education*, Cambridge MA: Harvard University Press
- Bruner J (1966) *Towards a theory of instruction*. Cambridge MA: Harvard University Press
- Bruner J (1990) *Acts of meaning*, Cambridge MA: Harvard University Press
- Bruner J (1996) *The Culture of Education*, Cambridge MA: Harvard University Press
- Burns R & Smith G (2005) Designing spaces for learning. In: *Blurring the boundaries, sharpening the focus*, CD Proceedings of the 2005 biennial conference of the Australian Curriculum Studies Association, University of the Sunshine Coast
- Capra F (1996) *The web of life: a new synthesis of mind and matter*, London: Harper Collins (also published as: Capra F (1996) *The web of life: A new scientific understanding of living systems*. New York: Anchor Books)
- Capra F (2002) *The hidden connections: integrating the biological, cognitive, and social dimensions of life into a science of sustainability*. New York: Doubleday
- Carr J & Begg A (1994) *Introducing box and whisker plots*. Paper presented at the 4th International Conference on Teaching Statistics, Marrakech
- Cattengo C (1988) *The mind teaches the brain*. New York: Educational Solutions
- Casti J (1994) *Complexification: explaining a paradoxical world through the science of surprise*. New York: HarperCollins
- Cesar M (1998) *Personal communication* (at 5<sup>th</sup> ICOTS conference, Singapore)
- Chalmers F G (2004) Learning from histories of art education: an overview of research and issues. In Eisner E & Day M (Eds) *Handbook of research and policy in art education*. Mahwah NJ: Lawrence Erlbaum Associates



- Chardin P (1955) *La phénoméne humain*. Editions du Seuil. (English translation, 1974, *The phenomenon of man*, London: Fontana, translated by Bernard Wall)
- Clandinin D J & Connelly F M (2000) *Narrative Inquiry: experience and story in qualitative research*. San Francisco: Jossey-Bass
- Clark E (1997) *Designing and implementing an integrated curriculum: a student-centered approach*. Brandon VT: Holistic Education Press
- Claxton G (1997) *Hare brain, tortoise mind: why intelligence increases when you think less*. London: Fourth Estate
- Claxton G (1999) *Wise-Up: the challenge of life long learning*. London: Bloomsbury Publishing
- Claxton G (2002) *Building learning power: how to help young people become better learners*. Bristol UK: TLO Ltd
- Claxton G (2004) Mathematics and the mind gym: how subject teaching develops a learning mentality. *For the learning of mathematics*, 24(2), pp. 27–32
- Cobb P (1999) Individual and collective mathematical development: the case of statistical data analysis. *Mathematical thinking and learning* 1(1), pp. 5–43
- Cockcroft W (Chair) (1982) *Mathematics counts*, London: Her Majesty's Stationery Office (Report of the Committee of Inquiry into the Teaching of Mathematics in Schools, DES & WO)
- Confrey J (1994) A theory of intellectual development. *For the learning of mathematics* 14(3), pp. 2–8
- Cox D (1998) Statistics for the millenium: some remarks on statistical education. *The Statistician* 47(1), pp. 211–213
- Crowley M (1987) The van Hiele Model of the development of geometric thought. In: Lindquist M & Shulte A (Eds) *Learning and teaching geometry, K–12*. Reston VA: National Council of Teachers of Mathematics (1987 Yearbook)
- Damasio A (1994) *Descartes' error: emotion, reason, and the human brain*, New York: G P Putnam's Sons
- Damasio A (2000) *The feeling of what happens*, New York: Harvest Books/Harcourt
- D'Ambrosio U (1984) Socio-cultural bases for mathematics education. In: Carss M (Ed.) (1986) *Proceedings of the Fifth International Congress on Mathematics Education* (Adelaide, August 1984) Boston: Birkhäuser, pp. 1–6
- D'Ambrosio U (2006) *The scenario thirty years later*. Plenary keynote address at the Third International Conference on Ethnomathematics, Auckland
- Davis B (1996) *Teaching mathematics: toward a sound alternative*, New York: Garland Publishing Inc
- Davis B & Simmt E (2003) Understanding learning systems: mathematics education and complexity science. *Journal of Research in Mathematics Education*, 34(2), pp. 137–167
- Davis B, Sumara D, & Kieren T (1996) Cognition, co-emergence, curriculum. *Journal of Curriculum Studies* 28(2), pp. 151–169
- Davis B, Sumara D, & Luce-Kapler R (2000) *Engaging minds: learning and teaching in a complex world*, Mahwah NJ: Lawrence Erlbaum
- Davis P & Hersh R (1981) *The mathematical experience*, Boston: Birkhäuser.

- Dawson S (1999) The enactivist perspective on teacher development: 'a path laid while walking'. In: Jaworski B, Wood T & Dawson S (Eds) *Mathematics teacher education: critical international perspectives*, London: Falmer Press, pp. 148–162
- Deleuze G & Guattari F (1988) *A thousand plateaus: capitalism and schizophrenia*, London: The Athlone Press (translated by B Massumi, originally published as *Mille plateaux*, volume 2 of *Capitalisme et schizophrénie*, 1980, Paris: Les Editions de Minuit)
- Department of Education (1969) *Mathematics: Primer 1 to Standard 4, Syllabus for Schools*. Wellington: Department of Education
- Department of Education (1972) *Mathematics: Forms 1 to 4, Syllabus for Schools*. Wellington: Department of Education
- Department of Education (1985) *Mathematics: Junior Classes to Standard Four, Syllabus for Schools*. Wellington: Department of Education
- Department of Education (1985–1989) *Mathnews 11–22* (An occasional newsletter for form 1 to 7 mathematics teachers). Wellington: CDD, Dept of Education (Editor: A Begg)
- Department of Education (1986a) *Mathematics, Forms 1 to 4, Introduction*, Wellington, Department of Education (Editor: A Begg)
- Department of Education (1986b) *Mathematics, Forms 3 and 4, Ideas*, Wellington, Department of Education (Editor: A Begg)
- Department of Education (1986c) *Mathematics with Statistics, Form 7*, Wellington, Department of Education (Editor: A Begg)
- Department of Education (1986d) *Mathematics with Calculus, Form 7*, Wellington, Department of Education (Editor: A Begg)
- Department of Education (1986e) *Curriculum review: some guidelines for high schools developing their curriculum*. (Draft edition for comment), Wellington: Department of Education (Editor: A Begg)
- Department of Education (1986f) *Mathprints #1: (Black line masters for teachers)* Wellington, CDD, Department of Education (Editor: A Begg)
- Department of Education (1986g) *Maths Discussion Starters* (Development kit), Wellington, CDD, Department of Education (Editor: A Begg)
- Department of Education (1987) *Mathematics: Forms 1 to 4, Syllabus for Schools*. Wellington: Department of Education
- Department of Education/Ministry of Education (1987–1991) *Maths at work, Maths in the artificial environment, Maths at play, Maths in the natural environment, Maths at home*, a series of 5 'Mathpix picture packs'. Wellington, Learning Media, Ministry of Education (Concept originator & editor: A Begg)
- Department of Education (1988a) *Mathematics with Statistics Supplement, Form 7*, Wellington, CDD, Dept of Education (Editor: A Begg)
- Department of Education (1988b) *Some ideas on assessment: mathematics, forms 3–7*, Wellington, CDD, Dept of Education (Editor: A Begg)
- Department of Education (1989) *Draft Syllabus Mathematics: Forms 5 to 7*. Wellington: Department of Education

- Depraz N, Varela F, & Vermersch P (2002) *On becoming aware: a pragmatics of experiencing*, Amsterdam/Philadelphia PA: John Benjamins Publishing Company
- Dewey J (1902) *The child and the curriculum*, Chicago: University of Chicago Press (1966 edition)
- Dewey J (1916) *Democracy and education: an introduction to the philosophy of education*, New York: The Free Press (1966 edition)
- Dewey J (1938a) *Experience and education*, New York: Kappa Delta Pi (1997 edition, New York: Touchstone)
- Dewey J (1938b/1997) *Power and knowledge: selected interviews and other writings*, New York: Touchstone
- Dienes Z (1963) *An experimental study of mathematics-learning*, London: Hutchinson Educational
- Doll W (1993) *A post-modern perspective on curriculum*. New York: Teachers College Press
- Donaldson M (1992) *Human minds: an exploration*. New York: Allen Lane/Penguin
- Eco U (1992) Overinterpreting texts. In: Eco, Umberto with Rorty R, Culler J, & Brooke-Rose C (1992) *Interpretation and overinterpretation*, Cambridge; Cambridge University Press (Chapter 2, pp. 45–66)
- Edelman G (1987) *Neural Darwinism : the theory of neuronal group selection*, New York: Basic Books
- Edwards B (1989) *Drawing on the right side of the brain*. USA: Tarcher
- Egan K (1996) *The educated mind: how cognitive tools shape our understanding*, Chicago & London: University of Chicago Press
- Engelbrecht J & Harding A (2001) *Mathematics is not got grown ups*, Seminar, Mathematics Education Unit, University of Auckland
- Engler J (1984) Buddhist psychology: contributions to Western psychological theory. In: Molino A (Ed.) (1998) *The couch and the tree: dialogues in psychoanalysis and Buddhism*, New York: Farrar, Straus & Giroux
- Fairhall U (ca. 2001) *Personal communication*
- Firsov V (1996) *Russian standards: concepts and decisions*. Paper presented to the 8<sup>th</sup> International Congress on Mathematics Education, Seville
- Flewelling G (2002) *We need learning tasks that support sense making*. Paper presented at the International Conference ‘The humanistic renaissance in mathematics education’ Palermo (Mathematics Education into the 21<sup>st</sup> Century Project)
- Foucault M (1980) *Power and knowledge: selected interviews and other writings, 1972–1977*, Brighton: Harvester Press
- Freire P (1972) *Pedagogy of the oppressed*, Harmondsworth: Penguin Books (Translated by M Ramos)
- Fromm E (1957) *The art of loving*, London: George Allen and Unwin.
- Fromm E (1978) *To have or to be?* London: Sphere Books (Abacus edition).
- Fromm E (1993) *The art of being*, London: Constable and Company

- Fromm E (1994) *The art of listening*, London: Constable and Company
- Gadamer H-G (1988) *Truth and method*, (Second revised edition, 2000). New York: Continuum Publishing Company
- Gardner M (1978) *aha! Insight*. New York/San Francisco: Scientific American Inc. / W H Freeman & Company
- Gibran K (1926) *The prophet*, (1974 edition, London: Heinemann)
- Gilbert J (2005) *Catching the knowledge wave? The knowledge society and the future of education*. Wellington: NZCER Press
- Gilligan C (1982) *In a different voice: psychological theory and women's development*, Cambridge, MA: Harvard University Press
- Goleman D (1996) *Emotional intelligence: why it can matter more than I.Q.*, London: Bloomsbury
- Gollnick J (2005) *Religion and spirituality in the life cycle*. New York: Peter Lang Publishing (Vol 9 in the series, Studies in education and spirituality)
- Gravemeijer K (1994) *Developing realistic mathematics*. Utrecht: Freudenthal Institute
- Greene M (1990) Contestaire (A response to Bowman & Haggerson, 1990). In: Sears J & Marshall D (Eds) *Teaching and thinking about curriculum: critical inquiries*. New York: Teachers College Press (pp. 75–78)
- Greene M (1995) *Releasing the imagination: essays on education, the arts, and social change*, San Francisco: Jossey-Bass
- Grumet M (1988) *Bitter milk: women and teaching*. Amherst: University of Massachusetts Press (Cited in Blumenfeld-Jones, 1995)
- Grundy S (1987) *Curriculum: product or praxis?* London: Routledge Falmer
- Gunn S (2001) Enactivism and models for professional development. In: Gunn S & Begg A (Eds) *Mind, body and society: emerging understandings of knowing and learning*, Melbourne: University of Melbourne, Department of Mathematics and Statistics, pp. 95–103
- Gunn S (2003) *Re-visioning curriculum: an evolutionary perspective*. Unpublished paper
- Haggarty L (2006) *Personal communication*
- Hamilton M (2005) *We grow in the shade of each other: a study of connections, empowerment and learning in the middle years of schooling*. Unpublished DED thesis, Australian Catholic University
- Harris M (1990) *Common threads*. London: British Council (Exhibition & Catalogue, Begg A (Ed.), Modified catalogue for exhibition at Hamilton, NZ
- Hart T (2001) *From information to transformation: education for the evolution of consciousness*, New York: Peter Lang (Counterpoints Volume 162)
- Hatch J & Wisniewski R (1995) Life history and narrative: questions, issues and exemplary works. In: Hatch J & Wisniewski R, (Eds) *Life history and narrative*, London: Falmer Press (pp. 113–135)

- Heikkinen H (2002) Whatever is narrative research? In: Huttunen R, Heikkinen H & Syrjälä L (Eds) *Narrative research: voices of teachers and philosophers*, Jyväskylä Finland: SoPhi/(Dept. of Social Sciences, University of Jyväskylä) (pp. 13–28)
- Hersh R (1997) *What is mathematics, really?* London: Jonathan Cape
- Hoban G (2002) *Teacher learning for educational change: a systems thinking approach*. Buckingham/Philadelphia: Open University Press
- Holmes F (Chair) (1974) *Directions for educational development* (A report prepared by the advisory council on educational planning). Wellington, Government Printer
- Houssart J (2004) *Low attainers in primary mathematics: the whisperers and the maths fairy*. London & New York: RoutledgeFalmer
- Howe A (1996) Developments of science concepts within a Vygotskian framework. *Science Education* 80(1), pp. 35–51
- Huebner D (1985/1999) Spirituality and knowing. (Essay written in 1985). In: Hillis V (Ed.) (1999) *The lure of the transcendent: collected essays by Dwayne E Huebner*. Mahwah NJ: Lawrence Erlbaum Associates
- Humphrey D & Topping J (1961) *A shorter intermediate mechanics* (Second edition), London: Longmans, Green & Co Ltd. (First edition, 1949)
- Ilon, L (2000) Knowledge, labour and education, *Compare* 30(3), 275–282
- Jacobs J (2005) *Dark age ahead*. Toronto: Vintage Canada/Random House
- Jaworski B (1994) *Group communication*. (Nordic Conference on Mathematics Teaching, Lahti Finland)
- Joseph G (c1995) Notes taken at a seminar at the Centre for Science and Mathematics Education Research, University of Waikato
- Kabat-Zinn J (1994) *Wherever you go, there you are: mindfulness meditation in everyday life*. New York: Hyperion.
- Kabat-Zinn J (2005) *Coming to our senses: healing ourselves and the world through mindfulness*. New York: Hyperion
- Kelman H (1958) Psychoanalytic thought and Eastern wisdom. In: Molino A (Ed.) (1998) *The couch and the tree: dialogues in psychoanalysis and Buddhism*, New York: Farrar, Straus & Giroux
- Kemmis S with Fitzclarence L (1986) *Curriculum theorising: beyond reproduction theory*. Geelong: Deakin University
- Kieren T (1995) *Teaching in the middle: enactivist view on teaching and learning mathematics*. Invited plenary at Queens/Gage Canadian National Mathematics Leadership Conference: Queens University (Cited in Dawson, 1999)
- Kotásek J & Svecová J (1995) Czech Republic. In: Postlethwaite T (Ed.) *International Encyclopaedia of National Systems of Education* (2<sup>nd</sup> edition), Oxford: Pergamon, (pp. 257–265)
- Krishnamurti J (1956) *Education and the significance of life*, London: Victor Gollancz
- Langer E (1989) *Mindfulness*. Reading MA: Addison-Wesley Publishing Company

- Langer E (1997) *The power of mindful learning*. Reading MA: Addison-Wesley Publishing Company
- Langer E (2005) *On becoming an artist: reinventing yourself through mindful creativity* New York: Ballantine Books.
- Lave J & Wenger E (1991) *Situated learning: legitimate peripheral participation*. Cambridge: Cambridge University Press
- Lincoln Y & Guba E (1985) *Naturalistic inquiry*, London: Sage Publications
- Little W, Fowler H, Coulson J & Onions C (1956) *The Shorter Oxford English Dictionary*. Oxford: Oxford University Press
- Luhmann N (1995/1984) *Social systems*. Stanford CA: Stanford University Press. (Translated by Bednarz J with Baecker D, Originally published in German in 1984 as: *Soziale Systeme: Grundriß einer allgemeinen Theorie*, Suhrkamp Verlag Frankfurt am Main)
- Mann D (1987) *Correspondences: the shaping of a school*, Palmerston North: Dunmore Press
- Marton F & Booth S (1997) *Learning and awareness*, Mahwah NJ: Lawrence Erlbaum Associates
- Maslow A (1964) *Religions, values and peak experiences*. New York: Viking Press
- Mason J (1998) Researching from the inside in mathematics education. In: Sierpinska A & Kilpatrick J (Eds) *Mathematics education as a research domain: a search for identity*, Dordrecht: Kluwer Academic Press, 357–377
- Mason J (2001) *Workshop notes*, Johor Baru. [Also in: Mason J & Johnston-Wilder S (Eds) (2004) *Fundamental constructs in mathematics education*, London/New York: RoutledgeFalmer]
- Mason J (2002a) *Researching your own practice: the discipline of noticing*, London: Routledge/Falmer
- Mason J (2002b) *Personal communication*
- Mason J (2002c) Generalisation and algebra: exploiting children's powers. In: Haggarty L (Ed.) *Aspects of teaching secondary mathematics; perspectives on practice*, London: RoutledgeFalmer, pp. 105–120
- Mason J (2005) *Personal communication*
- Mason J (2006) *Personal communication*
- Mason J & Johnston-Wilder S (Eds) (2004) *Fundamental constructs in mathematics education*, London/New York: RoutledgeFalmer
- Maturana H (1970) *Biology of cognition*. Biological Computer Lab. Research Report 9.0, Urbana: University of Illinois (Reprinted, Maturana & Varela, 1980)
- Maturana H & Varela F (1980) *Autopoiesis and cognition: the realization of the living*. Dordrecht: Reidel
- Maturana H & Varela F (1987) *The tree of knowledge: the biological roots of human understanding*, Boston MA: Shambhala Press
- Meriläinen & Syrjälä (2002) Autobiographical writing as a self-construction. Towards a duography. In: Huttunen R, Heikkinen H & Syrjälä L (Eds) *Narrative research: voices of teachers and philosophers*, Jyväskylä Finland: SoPhi/(Dept. of Social Sciences, University of Jyväskylä) (pp. 157–172)

- Merleau-Ponty M (1962) *Phenomenology of perception*, London: Routledge & Kegan Paul (Translated from the French by C Smith)
- Merleau-Ponty M (1964) *Primacy of perception*, Evanston, IL: Northwestern University Press
- Miller J (1996) *The holistic curriculum*. (Revised and expanded edition) Toronto: OISE Press, (Ontario Institute for Studies in Education)
- Mingers J (1995) *Self-producing systems: implications and applications of autopoiesis*, New York: Plenum Press
- Ministry of Education (1992) *Mathematics in the New Zealand Curriculum*, Wellington: Learning Media/Ministry of Education
- Ministry of Education (1993) *The New Zealand Curriculum Framework*. Wellington: Learning Media/Ministry of Education
- Ministry of Education (1994) *Pangarau*, Wellington: Learning Media/Ministry of Education, (Mathematics Curriculum—Maori version)
- Moustakas C (1990) *Heuristic research: design, methodology, and applications*, Newbury Park CA: Sage Publications
- Munro R (1969) (Chair) *Education in change: report of the curriculum review group of the New Zealand Post Primary Teachers' Association*, Auckland: Longman Paul (with NZPPTA)
- Nairn M, Hall G & Begg A (1966) *Secondary school arithmetic*. England, Edward Arnold
- Nairn M, Hall G & Begg A (1968) *Elementary secondary school trigonometry*. England, Edward Arnold
- Naisbitt J & Aburdene P (1990) *Megatrends 2000: the next ten years ... major changes in your life and world*. London: Sidgwick & Jackson
- National Council of Teachers of Mathematics (1989) *Curriculum and evaluation standards for school mathematics*. Reston VA: National Council of Teachers of Mathematics
- Neill A (1962) *Summerhill: a radical approach to education*. London: Gollancz (1968 edition, Harmondsworth : Penguin)
- New Zealand Qualifications Authority (1995) *Quality assurance for degrees and related qualifications*, Wellington: NZ Qualifications Authority
- Neyland J (2001) *An ethical critique of technocratic mathematics education: towards an ethical philosophy of mathematics education*. Unpublished PhD thesis, Wellington: Victoria University of Wellington
- Nhat Hanh T (1987) *The miracle of mindfulness: a manual on meditation* (Revised edition). Boston: Beacon Press. (First published in 1975 as: *Phép la của su tinh thuc*, translated by Mobi Ho)
- Noddings N (1992) *The challenge to care in schools*, New York: Teachers College Press
- O'Neill P, Laidlaw M, Maseyk N, Parr R, Spence R & Begg A (1973a) *Units in mathematics, Series T*. Wellington: A H & A W Reed
- O'Neill P, Laidlaw M, Maseyk N, Parr R, Spence R & Begg A (1973b) *Units in mathematics, Series F*. Wellington: A H & A W Reed

- O'Neill P, Laidlaw M, Maseyk N, Parr R, Spence R & Begg A (1974) *Units in mathematics, Series V*. Wellington: A H & A W Reed
- O'Neill P, Laidlaw M, Maseyk N, Parr R, Spence R, Begg A, & Lee P-Y (1972a) *The shape of mathematics 3A*. Wellington: A H & A W Reed
- O'Neill P, Laidlaw M, Maseyk N, Parr R, Spence R, Begg A, & Lee P-Y (1972b) *The shape of mathematics 3B*. Wellington: A H & A W Reed
- O'Riley P (1998) *Troubling research: regenerating technology discourses and educational inquiry as "mutual learning" conversations*, Paper presented at the conference of the NZ Association for Research in Education, Dunedin
- Osborne R & Freyberg P (Eds) (1985) *Learning in science: the implications of children's science*. Auckland: Heineman
- Papy (1963) *Mathématique moderne I*, Brussels & Paris: Marcel Didier.  
[English version: Papy (1968) *Modern mathematics I*, London: Collier-Macmillan Ltd, Translated by F Gerner.]
- Papy (1967) *Mathématique moderne 2*, Brussels & Paris: Marcel Didier.
- Pearsall J (2001)(Ed.) *The concise Oxford dictionary* (10<sup>th</sup> edition, revised) New York/Oxford: Oxford University Press.
- Peter-Koop A, Santos-Wagner V, Breen C & Begg A (Eds) *Collaboration in teacher education*, Dordrecht: Kluwer
- Piaget J (1937) *La Construction du réel chez l'enfant*. Neuchâtel: Delachaux et Niestlé [1954, *The construction of reality in the child*. New York: Basic Books, translated by Cook M]
- Plotkin H (1998) *Evolution in mind: an introduction to evolutionary psychology*, Cambridge MA: Harvard University Press
- Polanyi M (1958) *Personal knowledge*, London: Routledge & Kegan Paul
- Pólya G (1957) *How to solve it: a new aspect of mathematical method*, New York: Doubleday
- Postlethwaite T (2003) Educational research and educational policy-making in Asian and Pacific countries. In: Keeves J & Watanabe R (Eds) *International Handbook of Educational Research in the Asia-Pacific Region*, Dordrecht: Kluwer, Part 1, pp. 93–106
- Postman N & Weingartner C (1971) *Teaching as a subversive activity*, Harmondsworth: Penguin
- PrIME Project (1987) *One year of CAN—reflection of a year's work*. Homerton College, Cambridge [CAN being the 'Calculator Aware Number' part of PrIME, the 'Primary Initiatives in Mathematics Education' project]
- PrIME Project (1989) *The second year of CAN*. Homerton College, Cambridge
- Print M (1987) *Curriculum development and design*. London: Allen & Unwin
- Ralston A (1994) A zero-based curriculum, *ICMI Bulletin 36* (Reprinted in *ICMI (NZ)/10*)
- Raunft R (Ed.) (2001) *The autobiographical lectures of some prominent art educators*. Reston VA: National Art Education Association. (Cited in Chalmers 2004, p.15)



- Reagan T (2000) *Non-western educational traditions: alternative approaches to educational thought and practice*, (Second edition). Mahwah NJ: Lawrence Erlbaum Associates
- Renwick W (1979) *Marrying the spirit of the age*, Paper presented to the Australian Capital Territory Institute of Education Administration, Canberra, 7 Nov 1979, Reprinted in: Renwick W (1986) *Moving targets: six essays on educational policy*. Wellington: NZ Council for Educational Research (pp. 103–124)
- Renwick W (1986) *Moving targets: six essays on educational policy*. Wellington: NZ Council for Educational Research
- Resnick L & Ford W (1981) *The psychology of mathematics for instruction*. Hillsdale NJ: Lawrence Erlbaum
- Robinson I (1989) The empowerment paradigm for the professional development of teachers of mathematics. In: Ellerton N & Clements M (Eds) *School mathematics: the challenge to change*, Geelong: Deakin University Press, pp. 269–183
- Rogers C (1969) *Freedom to learn*. Columbus OH: Charles E Merrill Publishing
- Rogers C (1978) *Carl Rogers on personal power*. London: Consatble and Company
- Rogers C (1980) *A way of being*. Boston: Houghton Mifflin Company
- Salomon G & Perkins D (1998) Individual and social aspects of learning. *Review of Research in Education* 23, pp. 1–24
- Saul J (1992) *Voltaire's bastards: the dictatorship of reason in the West*, Toronto: Penguin Books
- Schön D (1983) *The reflective practitioner: how professionals think in action*, New York: Basic Books Inc
- Shakespeare W (1600) *As you like it*
- Shaw H (1983) *Personal communication* (in CDD)
- Shepard L (2000) *The role of classroom assessment in teaching and learning*, (CSE Technical Report 517). Los Angeles & Santa Cruz: University of California, Centre for the Study of Evaluation & Centre for Research on Education
- Skinner B (1953) *Science and human behaviour*, New York: Macmillan
- Smith A (2004) *Making mathematics count?* UK: DfES  
(Available on: <http://www.mathsinquiry.org.uk/report/index.html>)
- Smith D (2003) Preface: some thoughts on living in-between. In: Hasebe-Ludt E & Hurren W (Eds) *Curriculum intertext*, New York: Peter Lang (Counterpoints vol. 193), pp. xv–xvii
- Stenhouse L (1975) *An introduction to curriculum research and development*, London: Heinemann
- Stigler J (1994) *Learning mathematics from classroom instruction: cross cultural and experimental perspectives*. (Notes taken from presentation) at 17<sup>th</sup> conference of MERGA, Lismore NSW
- Taylor P (1997) *A senior high school math text-book In Process*, Kingston Canada: Queen's University

- Thomas W (Chair) (1943) *The post-primary school curriculum*, Wellington: Department of Education. (Report of committee appointed by the Minister of Education in 1942)
- Thorndike E (1922) *The psychology of arithmetic*. New York: The Macmillan Company
- Tripp D (1993) *Critical incidents in teaching: developing professional judgement*, London: Routledge
- Van Manen M (1990) *Researching lived experience: human science for an action sensitive pedagogy*, London Ontario: The Althouse Press, University of Western Ontario (for State University of New York)
- Van Manen M (Ed.) (2002) *Writing in the dark: phenomenological studies in interpretive inquiry*. London, Ontario: The Althouse Press, University of Western Ontario (& reprinted by the State University of New York Press)
- Varela F (1987) Laying down a path while walking. In: Thompson W (Ed.) *Gaia: a way of knowing*, Barrington MA: Lindisfarne Press
- Varela F (1999) *Ethical know-how: action, wisdom and cognition*. Stanford: Stanford University Press
- Varela F, Thompson E & Rosch E (1991) *The embodied mind: cognitive science and human experience*, Cambridge MA: MIT Press
- Vaseo S & Hinton L (2005) Learning to think: philosophy in the classroom. In: *Blurring the boundaries, sharpening the focus*, CD Proceedings of the 2005 biennial conference of the Australian Curriculum Studies Association, University of the Sunshine Coast
- Vere-Jones D & Begg A (1989) *Some Emerging Changes in Statistics Education in New Zealand Schools*. In: Conference proceedings of the 7th Session of the International Statistical Institute. ISI, Paris, pp. 199–207
- von Glasersfeld E (1983) Learning as a constructive activity. *PME-NA Proceedings*, Montreal, 1983, pp. 41–69
- von Glasersfeld E (1990) An exposition of constructivism: why some like it radical. In: Davis R, Maher C, & Noddings N (eds.) (1990) *Constructivist views on the teaching and learning of mathematics*. Reston VA: National Council of Teachers of Mathematics (JRME, Monograph # 4), pp. 19–29
- von Glasersfeld E (1995) *Radical constructivism: a way of knowing and learning*, London: Falmer Press
- von Glasersfeld E (2000) *Personal communication* (after seminar), at the University of Massachusetts, Amherst
- Vygotsky L (1962) *Thought and language*. (Edited and translated by E Hanfmann & G Vakar), Cambridge MA, MIT Press
- Vygotsky L (1978) *Mind in society: the development of higher psychological processes*. Cambridge MA: Harvard University Press. (Edited by M Cole, V John-Steiner, S Scribner & E Souberman)
- Walker, A (2005) *Now is the time to open your heart*. New York: Ballantine/Random House

- Wertheimer M (1980) Gestalt theory of learning. In: Gazda G & Corsini R (Eds) *Theories of learning: a cooperative approach*. Itasca IL: F E Peacock Publishers (Chapter 7, pp. 208–251)
- Wheatley M (1992) *Leadership and the new science; learning about organization from an orderly universe*, San Francisco: Berrett-Koehler Publishers Inc
- Whitehead A (1911) *An introduction to mathematics*, (Reprinted (1948) Oxford: Oxford University Press
- Whitehead A (1927–28/1978) *Process and reality: an essay in cosmology*. (1927–28: Gifford lectures delivered in the University of Edinburgh, (Reprinted 1978: Corrected edition, edited by Griffin D & Sherburne D) New York: The Free Press
- Whitehead A (1932) *The aims of education and other essays*, London: Williams & Norgate
- Wigley A (1992) Models for teaching mathematics. In *MT141*, (pp. 4–7)
- Wood D, Bruner J, & Ross G (1976) The role of tutoring in problem solving. *Journal of child psychology*, 17, pp. 89–100 (Cited in: Mason J & Johnston-Wilder S, 2004)
- Wragg E (1997) *The cubic curriculum*. London: Routledge
- Young M (1998) *The curriculum of the future: from the 'new sociology of education' to a critical theory of learning*, London: Falmer